Metallurgical and Chemical Engineering

Contents for January 15, 1917

A Riot of Organization

"Organization," says H. G. Wells in an essay lately
published, "is the life of material and the death of
mental and spiritual processes." That is one of those
observations that holds true from one angle of vision
and is clearly false from another. If we were to say
that organization as an end, rather than as a means to
an end, kills mental and spiritual processes, there would
be few to contradict it. And despite the chaotic state
of chemical industry in this country to-day, and the
need of organization right and left, it is worth while
to remember that over-organization is as bad as dis-
order.

Nearly every one of us has some little trick that he
can perform better than he can do other things, and
there is good advice from all grades of intelligence,
from genius to orthodoxy, to the effect that we should
conserve our talents. But if we were so organized that
each of us were under compulsion to repeat his one
little trick, over and over again, the livelong day, we
should lose in imagination what we should gain in effi-
ciency.

Francis Hackett, whose wit is sharper than every-
body can see, lately proposed that eugenics be employed
to breed a race of efficient industrial workers who shall
be strong, healthy, good-natured and exceedingly dull.
In short, he proposes (in satire) a race of morons, of
feeble-minded but strong-bodied workers, for efficiency.
But the fact is, there are in process of breeding feeble-
minded in vast number, and the great task is, as we
have said before, to find employment for them. Since
manufacturers will not have them if they can help it,
the labor unions have had to take them on and slow
down their gait to meet the limitations of their dull
and incompetent members. The organization of the
feeble-minded along with whole men, lest the weak ones
starve, is one of the leading reasons why collective
bargaining with labor unions is so difficult.

We have in mind a great works the pot-bellied author-
ities of which point with pride to the speed with
which their hands are able to do the same task over and
over again throughout the long days and weeks and
months and years. The error lies in the belief that the
monotony of speed at one task will be profitable through-
out the years. They are putting whole men at work
designed for the feeble of wit, and just as depreciated
currency returns to its source, so the mentally helpless
will drift to the jobs designed for them. And good men
will degenerate or go away.

Now as many useful ideas emanate from the shop
as from the drafting room, and if the men in the
shop work as machines rather than as men, or with

their minds asleep, the output may not go down, but somebody else will soon come along with something better.

We can organize the life out of factory practice, and thus cause a waste of men and of ideas on the one hand that is more dangerous than the waste of material and time that comes from the lack of organization.

Economies in Steel Manufacture

The steel industry has always been crying for more capital. When the Payne-Aldrich tariff was under advisement a number of steel manufacturers went down to Washington and asserted that the only way to make money in the steel industry was by selling out. The statement was calculated as a rejoinder to Mr. Carnegie's testimony to the effect that the steel industry did not need protection. Mr. Carnegie was rich—but he had sold out! There was a large element of truth in the statement, however. One could make money in the steel business, perhaps, but he could not take it out; he could not "cash in." There was always the necessity of spending the earnings.

For the first time in the history of the American steel trade there are earnings so large that there is no occasion to spend the major portion of them in plant extensions, in order that each one may keep pace with his neighbor and nobody fall behind. It is impossible, indeed, to spend the major part of the money because there are not enough workmen and makers of supplies, equipment, etc., willing to accept the money. There is a large works extension program being carried out, but it is not absorbing the profits nearly as fast as they are being made. All the improvements made in this expansive movement, which began about the middle of 1915, and all still to be made, would only total in the neighborhood, probably, of $300,000,000 to $400,000,000, or perhaps a trifle less than the surplus earnings to date, beyond all charges and the ordinary dividend requirements. There are still large earnings in prospect.

The new construction program, however, is regarded in the trade as very nearly a finality as regards increase in tonnage output. Further improvements that may be made will be in the direction of introducing still greater economies in manufacture, partly by way of saving money on the cost sheet and partly by way of making new products, carrying the steel to a greater degree of finish, and making by-products, of which there may be many apart from the well recognized by-product of the retort coke oven.

As to these refinements the steel industry is in no hurry. Most of them cannot well be undertaken when works are being driven to produce the last ton of steel possible, or when labor and supplies are scarce. The time will come for them in due course.

Of the refinements that are to be considered the further reduction in labor must stand prominent, from both the social and the economic viewpoint. The 12-hour day really has no friends, those who are its sponsors merely considering it a necessity in the circumstances. The iron and steel industry's labor has been supplied largely by immigration. During the two fiscal years before the war the increase in population of the United States, due to excess of arrivals over departures, averaged 50,000 a month. Since the war started the increase has been light and what may be called a deficiency, having regard to the previous rate, has accumulated to the extent of more than 1,000,000. After the war there will hardly be much of an influx of able-bodied men such as could be recruited into the industry. With a lessened supply of labor in proportion to the industry's growth and with a tendency to shorten the hours of labor the unskilled labor must be displaced more and more by machinery, and the industry will not find itself, as it occasionally has in the past, with neither the money to pay the men nor the money to buy the machinery with which to replace them.

By-Product Coke

A function, if not a use, has been found for the bee-hive coke oven, to take the peak off the load. According to the estimate just made by the Geological Survey coke production in 1916 was about 19,200,000 net tons by the by-product process and 35,100,000 tons by the beehive oven, making a total of 54,300,000 tons. Although the increase in by-product coke from 1915 to 1916 was 36 per cent, the increase in the proportion of by-product to total coke was only from 34 to 35 per cent. The production of beehive coke had "come back" under stress of demand so that the year's tonnage was substantially equal to the record tonnage, made in 1907, when it constituted 86 per cent of the total output. In the intermediate years the tonnage was much less.

The demand for coke, inasmuch as 80 per cent of the total output, on an average, is used in the manufacture of pig iron, fluctuates widely. By reason of the large investment involved in by-product ovens it is desirable that they should operate with a fair degree of continuity, and it will be convenient to have the bee-hive ovens to fall back upon at times, to eke out when there is an extraordinary demand.

By-product coking practice, in the latest developments, has been kinder to the bee-hive coking coal fields than was expected. The wind has been tempered to the shorn lamb. In recent years there has been a trend toward larger proportions of the coals hitherto used in bee-hive practice than had been anticipated, and thus the bee-hive operations can continue, by shipping their coal to by-product ovens, and in times of stress increasing their coal output and coking the excess in their old bee-hive ovens.

The number of by-product ovens completed at the beginning of this year has not yet been reported, but the number on January 1, 1916, was recently reported at 6268, and the number since completed, or now under construction, will bring the total to about 9000 retorts. The actual statistics of production do not reflect the outputs claimed possible with ovens as now built, but the newer ovens will doubtless do better. Giving the retort the benefit of the doubt, and assuming that only those completed by the beginning of a year contributed

to the year's output, the average output per retort has been, according to the Geological Survey's reports: 1912, 2400 tons; 1913, 2440 tons; 1914, 2130 tons; 1915, 2430 tons; 1916, 3050 tons. Most of these years were years of substantially full operation.

In the circumstances it seems perfectly safe to predict that the ovens now built and those being built will have a capacity of fully 30,000,000 net tons of coke per annum. When the blast furnaces now being built are completed the total pig iron capacity will be close to 45,000,000 tons a year, requiring in the neighborhood, according to the experience of 1915, about 50,000,000 tons of coke a year. Thus there is still much room for growth in the by-product coke industry.

Laziness, Efficiency and the Efficient Laziness

In Mark Twain's classic we find that the youthful hero "Tom Sawyer" had on a Saturday the hard job of whitewashing a fence thirty yards long and nine feet high. His thoughts wandered to the swimming hole. He was feeling just so "plum lazy" that he did not like the appalling task. So he thought, as the real prototype of the modern efficiency that he would use his head rather than his hands, and accordingly placed his job before his friends in the pleasing light of that of a noble craftsman. We all know the sequel. He got his pals to pay for the privilege of doing his work for him and he arrived at "the efficient laziness."

Now, laziness with us has an unpleasant connotation suggestive of the "bum," and usually means the disinclination to do honest work of any kind. But it can carry the further meaning of the disinclination to do any unnecessary work and of the desire to get machinery to perform the work and not waste energy. We believe that from the all-pervasive human tendency to do no work, or at least a minimum of work, perforce is born the inventive instinct, and in this secondary meaning of laziness there is a lesson. From the lazy notion that the unloading of dirt from a cart was hard work came the dump-cart. The disinclination to delve, developed the plough. A tread-mill is a poor prime-mover —hard, laborious effort of man or beast produces only a few foot-pounds per minute. But Watts made the stored-up sunlight of ages produce the equivalent of many men and horses. Doubtless, the steady grind of the tread-mill is good to an extent for both man or beast, but it is not elevating to them, either in a spiritual or in a physical sense. And the intelligent way was for man to develop some other prime-mover. The waterwheel turning round absorbs the potential energy of stored water. The old "overshot" wheel spilled and splashed round water, but was very inefficient. It made a fine show and was "beautiful," but it was not useful. A modern large turbine discharges its water in a slow and lazy stream into the tailrace and is efficient. The lazy man "cuts off" his steam and allows it to expand as happens in a Corliss engine.

Noise and splash are signs of activity, but not of intelligent activity. They show wasted effort. In all human endeavor, there is the attempt to perform the minimum effort and to produce the maximum result.

This is not exactly what we usually call laziness, but it surely is closely allied to laziness in its general meaning and it is "the efficient laziness." A lazy man is naturally graceful. He is so "darned lazy" that he will make no unnecessary motion and moves with languid ease and grace. He is not over-anxious or too eager. He does not slop over or waste his energy for he prizes energy so highly that he uses every bit of it. Impelled by the thought that he must live, he develops his intelligence and moves along the line of least resistance. To get out of doing hard work, he will devise and use levers, cams, electromagnets, relays, belts, clutches and gears. All these are born of the innate desire of man to escape effort, and out of this situation intelligence arises to give birth to expedients and other means to escape drudgery.

Just as the most beautiful flower, the rose, grows out of animal corruption, so does intelligence grow out of laziness.

Now, of course, there must be energy of some kind as the impelling force and without energy nothing can proceed, for the rationale of energy lies in its utilization. The command of nature is that energy must not be wasted by man. The prizefighter who spars with rigid muscles is quickly worsted by his antagonist who moves relaxed except at intervals of intense effort. The long-distance runner goes on his pace with a graceful lope if he is to be the winner. Whereas his competitor runner who bounces up on the muscle of his calves soon exhausts himself and an excess of uncontrolled energy is the cause of that great American malady, "nervousness." No lazy man fidgets.

Indeed, an intelligent and efficient laziness is the greatest of America's needs. "Pep," "punch" and "kick" are fine national assets, but to be using them continually soon dulls their edge and wastes them. Observe if you will the wild animals who have no consciousness to arouse them to pernicious activity. When they lie down, they are relaxed. When they move slow they move with a lazy motion. There is no living creature more efficiently lazy than the lion. When he moves fast he moves with no lost motion, and with a magnificent spring. He is the great unconscious engineer.

Engineering and invention proceed from laziness. Is there anything more conducive of laziness than the "slide rule?" So, then, while laziness, like manure, is not always pleasant and should be put under the ground out of sight, a clear understanding of the proper use of this supposedly smelly and not always agreeable human quality will help the chemist and engineer, but not if carried to the point of self-deceit. For laziness if unintelligent brings forth self-deceit. This, however, is not "the efficient laziness."

The efficient lazy man is the apogee of the sine-curve of intelligence. When he toils, he spins.

The stock proverb on this subject we know was "Go to the ant, thou sluggard, consider her ways and be wise." Should it not be, "Go to the sluggard, thou ant, consider her ways and be efficiently lazy." "Be sure when you nip the aphis-worm that you use only three nips, instead of the five that you have been using."

Readers' Views and Comments

A Personal Note

To the Editor of Metallurgical & Chemical Engineering

Sir:—With your permission, the undersigned would like to make public the fact that the "J. W. Richards" endorsing circulars recently issued exploiting Mr. Sydney J. Jennings for president of the American Institute of Mining Engineers, is Mr. John W. Richards of Denver, and not Dr. Joseph W. Richards, vice-president of the Institute and chairman of its Iron and Steel Committee.

Joseph W. Richards.

Lehigh University.

Our Wasting Water Powers

To the Editor of Metallurgical & Chemical Engineering

Sir:—Your journal is right in drawing again and again attention to the enormous importance of the water-power problem at Niagara and elsewhere at the present time.

Through a long course of legislative fatuousness our country has lost millions of dollars in wasted power, and stands to lose many millions more unless the present situation is remedied. The fundamental economic principle about hydraulic power is that every cubic foot of water that plunges downward unutilized is a sheer waste of inherent national wealth. If you do not dig up your coal or cut down your wood its fuel value remains, while in the case of unused water powers the water of the present runs to absolute waste. All the value which it represents is as completely lost as if it were T N T exploded at the front with the amiable intent of blowing a few fellow mortals off the earth.

When a country is only partly settled and manufacture is a casual rather than a vital industry the neglect of hydraulic privileges represents less immediate and serious loss, but as the nation's industrial resources are more and more thoroughly developed and particularly as electrochemical processes have come to take a greater and greater part in the economic result, neglected powers are more than regrettable, they are disastrous. Electrochemical works require plentiful and cheap power such as can be obtained only by the utilization on a big scale of the big streams, even navigable streams, as well as others in the public domain. And how great a part electrochemical processes play in manufacture apparently only remotely related to them your journal is continually pointing out.

The fullest possible power supply obtained within the shortest possible time is the fundamental requirement for that complete organization of American industry which is necessary to the prosperity of the nation now, and will be even more vital within the next few years. It is up to Congress to show some signs of patriotism and human intelligence instead of playing politics and talking buncombe in the effort to disconcert an alleged water power trust that does not exist. It is not remarkable that far-sighted folk should be interested in the development of water powers, and the movement toward this end is as spontaneous as hunting after any other article of well-known and established value.

Those who oppose hydraulic development fall into three categories: First, come the narrow-minded souls who shudder with fear lest somebody else make a dollar by judicious investment; second, that amiable group of socialistic proclivities, who want the Government to screw enough out of each projected enterprise to wreck it as a business proposition; and third, come the long-haired and mild-eyed sentimentalists who whine about dangers to the beauties of Niagara—for the last half century a dismal congeries of cheap hotels, boarding houses, bawling cabbies and open-mouthed bridal couples. The sentimental value of a great cataract is is not unworthy of consideration, but this particular one had lost all esthetic importance before the first power plant burrowed its tail-race through the cliffs.

The thing of vital importance to the country at the present time is that all the sources of hydraulic power which are economically available should be brought quickly into use so as to give modern industry a fair chance. The water which is not used to-day is lost capital. We need water power legislation which shall give encouragement toward the immediate development of every horsepower worth the while, with provision to protect the government in its ownership if you like, by regulation of prices and by limitation of charter rights, but constructive instead of destructive as at present.

It must be remembered that the most promising of such enterprises are big ones not to be carried out by a small investment and in a single season. They require large amounts of capital which can be had cheaply if reasonable security for its investment can be granted. Time, too, is required so that if two or three years from now there is to be cheap power for the multifarious uses men find for it, a beginning must be made at once.

Public service enterprises such as these do not resent reasonable supervision. They have on the contrary learned to expect it, but they cannot exist in the face of uncertainty with respect to reasonable profits and tolerable continuity of business. The tendency of legislation seems to be to cultivate uncertainty and to leave the would-be investor quite in the dark as to whether his property will be his own a few years from now or will have been in some way benevolently assimilated by the powers that be.

The important thing for far-sighted legislators to realize now is that the thing at stake has to do with the conditions of permanent prosperity as respects many of the country's big industries. It is a question of substituting frugality for waste, of building up instead of tearing down, of looking to the benefits of the future instead of whining over the peccadillos of the past.   L. B.

Boston, Mass.

The Recovery of Chinchonine from Any Solutions in Which It Is Used to Remove the Last Traces of Tungsten

To the Editor of Metallurgical & Chemical Engineering:

Sir:—Owing to the great advance in price and the difficulty encountered trying to procure chinchonine for the determination of tungsten, the writer has been using the following method to recover this reagent from filtrates in which it has been used.

Place the waste filtrates which contain the chinchonine into a suitable container until 5 or 10 gal. have accumulated. To this solution add slowly and with constant stirring a strong solution of commercial caustic soda until the solution is just slightly acid. When this

point is reached add an emulsion of zinc oxide until all the iron, etc., is precipitated. If when this point is reached the precipitate seems too thick so that no clear solution shows at the top, then add several liters of tap water and allow the precipitate to settle.

When the precipitate has entirely settled, decant off the clear solution. To this clear solution add ammonium hydroxide, having enough in excess to redissolve any zinc which might precipitate. The amount of ammonium hydroxide needed here will depend on the amount of zinc oxide needed to precipitate the iron, etc. If the solution was brought close enough to the neutral with caustic then the amount of zinc oxide will be smaller and it will not require such a large excess of ammonium hydroxide. Of course, if some zinc is precipitated with the cinchonine at this point it will not matter so much as it will be removed later during the process of purification. The only thing that the zinc does here is to retard filtration of the chinchonine.

When the ammoniacal solution is obtained it will also contain a grayish white precipitate of the impure chinchonine. Filter off this precipitate, using a Buchner funnel and suction. Wash the precipitate several times with hot water, suck dry and then dissolve the precipitate from the filter with hot (1-1) hydrochloric acid, washing the filter several times. This acid will dissolve the precipitate from the paper. To this solution add some tartartic acid and again make ammoniacal, a white precipitate of chinchonine should be obtained. This precipitate is filtered off and thoroughly washed with hot water, dried at 105 deg. C., and bottled for use in making chinchonine solutions.

The precipitate of iron from which the clear solution was decanted in the first place is stirred up and tap water added and the precipitate again allowed to settle and this clear solution again drawn off and the chinchonine recovered from this as explained. By making several decantations of this kind it has been able to recover at least 90 per cent of the chinchonine.

The filtrate from the purification of the first precipitation of the chinchonine is saved and used to precipitate the chinchonine from the second decantation from the iron precipitate. In this way a saving on the amount of ammonium hydroxide needed can be made.

Buffalo, N. Y.   E. W. HAGMAIER.

Coming Meetings and Events

Society of Chemical Industry, New York Section, Perkin Medal Award, New York, Jan. 19, 1917.

Joint meeting, New York Sections, American Electrochemical Society and American Institute of Mining Engineers. Machinery Club, New York, Jan. 26, 1917.

Joint meeting of New York Section of American Electrochemical Society, American Chemical Society and Society of Chemical Industry, Rumford Hall, Chemists' Club, New York, Feb. 9, 1917.

American Institute of Mining Engineers, annual meeting, New York, Feb. 19-22, 1917.

Meeting of New York Sections of American Electrochemical Society and American Institute of Mining Engineers

A joint meeting will be held on Friday evening, Jan. 26, by the New York Sections of the American Electrochemical Society and the American Institute of Mining Engineers. The topic of the evening will be "The Electrical Precipitation of Smoke and Dust." It will be a dinner meeting (charge $1.75, including drinks), and will be held at the Machinery Club, 50 Church Street, at 6.30 p. m. Messrs. Linn Bradley, W. W. Strong and A. F. Johnson will speak.

Western Metallurgical and Chemical Field
Gasoline from Oil Shales

A great deal if interest has of late been shown in various parts of the world in connection with the extraction of gasoline from shales rich in hydrocarbons. It is not impossible that in future, due to the advancing cost of gasoline from petroleum, means may be sought from which this much demanded product can be produced independent of the oil syndicate.

For three years the U. S. Geological Survey has investigated these deposits, the largest of which are found in the Green River formation of northwestern Colorado and northeastern Utah. These areas have been mapped out, their depths and length have been measured, and crude field tests have been made along the lines of distillation. The shales on distilling yield petroleum, the amount depending largely on the richness in hydrocarbons of the shales, which varies in different localities.

In the United States Geological Survey Press Bulletin for December, 1916, it is stated that 20,000,000,000 barrels of crude oil could be obtained by distilling such shale deposits ranging over 3 ft. in thickness in Colorado alone. This would yield in the neighborhood of 2,000,000,000 barrels of gasoline, an item of considerable importance. At present the Bureau has in press a report giving the results of the exploration, the tests made on the shales and an account of experiments made to determine the possible gasoline production, both by the ordinary commercial processes and by the Rittman process. This report should prove of great interest to gasoline producers and users.

The oil produced from some of these shales is dark brown in color, rather mobile, and has a dominant odor of the lighter hydrocarbons. The extent to which these latter are present may be judged from a sample kept in the writer's office. On receiving that sample directly from the source of distillation, it was put in a bottle and stoppered very tightly with an ordinary cork. After standing for three weeks the oil had become very viscous, had very little odor due to the lighter hydrocarbons, the main odor now being that typical of the product left on distilling ordinary petroleum for the lighter and more volatile constituents. This certainly seems to indicate that the percentage of volatile constituents is very high, which is a promising asset for the production of gasoline.

South Africa seems to offer another possible source for gasoline from bituminous shales. According to the *South African Mining Journal*, Aug. 19, 1916, page 460, such bituminous shales should not occur in metamorphic rocks, because any severe metamorphism destroys these shales. Bituminous shales are known to occur in the Black Shale group in Rhodesia. This deposit lies in the region of the Wankie Main coal fields. Other possible localities in South Africa are the main belt which stretches in a northeastern and southwestern direction through the Wankie and Sebungwe districts. This belt in the northwest expands and includes most of the country between the Great Escarpment and the Zambesi River, the northermost portions of the Lomagundi district, the Sabi coal field in the Ndanga district and the Umzingwane and Massabi fields in the Gwanda district. An interesting article on the occurrence of oil shales in Natal is found in the Oct. 28, 1916, number of the *South African Mining Journal*, by Alexander L. du Toit. Du Toit states that he has examined shales which produced 27.1 gal. of crude oil per ton of shale. On the other hand, reports have it that shales giving a far greater amount of crude oil have been tested.

Some general information regarding these shales may be of interest. Rich oil shale is very tough, burns on ignition and resists, to a remarkable extent, erosion.

On weathering these shales take on a bluish white color. A good oil shale should be dense in structure and flatten out to an adhering mass on pressing a small piece with the blade of a knife.

An item of interest in this country is that the Colorado oil shales yield a crude oil which gives 10 to 15 per cent gasoline by ordinary methods of refining. Furthermore, with little more investment 300,000,000 tons of ammonium sulphate could be derived from the Colorado shales. This product is of exceptional value as a fertilizer. The equipment for a plant handling these shales would be rather high, and comprise buildings, retorts, condensers, refining machinery and mining machinery. As in many other industries, the oil shale industry on a small scale would in all probability not pay.

Company Reports

The annual report of the *Buffalo Mines, Ltd.,* for the period commencing with May 1, 1915, and ending with April 30, 1916, shows that the mill treated 38,-157 tons. Of this 30,079 tons were treated by wet concentration, averaging 19.8 ounces of silver per ton, with a recovery of 431,512 ounces, and 8078 tons were treated by combination concentration and oil flotation, averaging 25.46 ounces of silver per ton, with a recovery of 197,601 ounces. The cyanide plant treated 6340 tons of slime from the concentrator, averaging 10.54 ounces of silver per ton, of which 55,161 ounces were recovered. The total silver recovery by mill and cyanide was 684,274 ounces.

The amalgamation plant and refinery treated 13,-465 lb. of high-grade directly from the mine, 285,554 lb. jig concentrates, 718,240 lb. table concentrates, 1952 lb. of metallics from the low-grade mill and 6662 lb. of precipitates from the cyanide plant. The total silver treated at the refinery was 812,020 ounces, part of which was at hand at the beginning of the year. The total bullion produced by this plant was 775,253 ounces of bullion and 4070 ounces scrap on hand giving a grand total of 779,323 fine ounces recovered, with residues still to be treated. The total production of silver, including sales of silver, silver on hand and unsettled for at smelter is 705,055 ounces.

The ore reserves are 8000 tons of broken ore ready for extraction, 5000 tons unbroken ore, 5000 tons of ore on the surface ore dumps, averaging about 18 ounces of silver; 300,000 tons of concentrator tailings containing 1,600,000 ounces of silver and 3000 tons of residues from the treatment of high-grade ore containing, besides silver values, cobalt, nickel and arsenic.

Experimental work has been conducted on the residues and tailings with very satisfactory results. Due to these results it has been decided to convert the mechanical concentrator to that of flotation. The flotation plant under construction will have a daily capacity of 600 tons. This tonnage will be distributed as follows: 450 tons of tails and 150 tons mine run ore.

Subsidiary Companies of the Tonopah Mining Company of Nevada.—The *Tonopah Placers Company,* operating at Breckenridge, Col., put two dredges in operation, one in March and one in May, 1915. Their operation was continued until December of the same year, at which time they were shut down on account of cold weather and for necessary repairs. During the past year the indebtedness of $93,750 contracted by the purchasing of the property was paid off. An initial dividend of 5 per cent was paid in December.

At the *Eden Mining Company,* operating in Nicaragua, C. A., due to litigation, the completion of the power plant and railroad has been greatly delayed, but at present the work is being rapidly prosecuted. During the past year the machinery for the mill was purchased. The erection of the buildings and installation of the machinery are now being carried on as fast as possible. J. L. Phillips has been elected general superintendent in charge of this property.

Work has been continued on the properties of the *Mizpah Extension Company* and *Tonopah and California Gold Mining Company,* at Tonopah, Nev. A settlement has been made with the Tonopah Extension Mining Company for the ore mined within the boundaries of the property of the Tonopah Mining Company of Nevada.

Chemistry at the Meeting of the American Association for the Advancement of Science

Symposium on the Structure of Matter

The structure of matter was the subject of a very interesting symposium at a joint meeting of the sections on physics and chemistry of the American Association for the Advancement of Science with the American Physical Society, the American Chemical Society, and the American Electrochemical Society, held at Columbia University on Wednesday, Dec. 27, 1916.

The chairman, Prof. **Julius Stieglitz,** referred in his introductory remarks to the wonderful strides made in recent years in the development of the theory of matter. The old alchemist's dream of transmutation has come true.

Prof. **R. A. Millikan** of the University of Chicago reviewed the epoch-making researches of J. J. Thomson, Rutherford, Lorentz, De Broglie and others, and emphasized the fact that radiation phenomena have been most instrumental in clearing up our understanding of the structure of matter. Barkla on the basis of his experiments calculated the number of electrons in the atoms of various elements and found this to be approximately equal to one-half the atomic weight. Undoubtedly among the most important contributions to the theory of the structure of the atom are those of Moseley. His work, too, was based on radiation. He found that the vibration frequency of an element increases as the atomic weight increases. Professor Millikan showed a number of new slides which illustrated in striking fashion the shifting of the two characteristic lines of an element toward the violet end of the spectrum upon passing from element of a lower to a higher atomic weight.

Prof. **Gilbert N. Lewis** of the University of California took exception to some of the theories of the structure of the atom which had been advanced in recent years, and pointed out that it was difficult to apply some of the modern conceptions to many of the organic molecules. He then briefly referred to his theory of polar and nonpolar molecules (Jour. Amer. Chem. Soc, 1916, p. 762). In the polar molecule the electrons move in such a way as to tend to separate the molecule into positive and negative parts, whereas in the nonpolar molecule the electrons do not move far from their original or normal positions. We cannot apply many of our familiar physical laws to the behavior of electrons and atoms; so, for example, Coulomb's law of inverse squares does not hold true at very small or atomic distances. We ought to try to preserve, however, the main body of the electromagnetic theory.

Prof. **Robert W. Wood** of Johns Hopkins University next read a paper on "molecular resonance and atomic

structure." He described an experiment in which he passed white light through sodium vapor and showed that light was absorbed by the vapor, but partially re-emitted. Sodium vapor will re-emit the D_1 line much more readily than the D_2 line. Iodine vapor has about 120 lines between the D_1 and D_2 lines, and a single one of these can be stimulated. If we excite the iodine vapor with the yellow line of the mercury vapor we get a different grouping of the doublets. Experiments seem to indicate that there is a resonator in the sodium or iodine molecule which does not obey Hook's law.

Wm. D. Harkins, professor of chemistry of the University of Chicago, had chosen for his topic "the evolution of the elements as related to the structure of the nuclei of atoms." With the aid of a number of tables he showed that the atomic weights of the first twenty-seven elements, beginning with helium, are not multiples of the atomic weight of hydrogen by a whole number, as they would be if Prouts' original hypothesis in its numerical form were true. However, when these atomic weights are examined critically it is found that they differ from the corresponding whole numbers by a nearly constant percentage difference, and that the deviation is negative in sign, with an average value of —0.77 per cent. This percentage difference has been called the "packing effect," and it represents the decrease of weight and presumably the decrease of mass, which must take place if atoms are complexes built up from H atoms.

The magnitude of the packing effect for helium is 0.77 per cent, so that if a more complex atom is built up of helium groups alone then, in general, nearly all of the packing effect is due to the primary formation of the helium nucleus from four hydrogen nuclei and two negative electrons, and almost no packing effect results from the aggregation of these helium nuclei into more complex atoms.

Professor Harkins described at some length how all the elements might be considered complex helium or helium-hydrogen atoms. He then proceeded to point out that the elements with even multiples of helium or helium and hydrogen are most prevalent.

A second paper by Prof. William D. Harkins of the University of Chicago discussed "the abundance of the elements in relation to the hydrogen-helium structure of the atoms."

According to the theory already presented in a number of papers the atoms of all the 91 elements of our ordinary system heavier than hydrogen are built up as intra-atomic (not chemical) compounds of hydrogen. The first of these 91 elements, helium, is the second in the system, and therefore has the atomic number 2. It has an atomic weight of 4.00, and may be considered to be composed of 4 hydrogen atoms. The element of atomic number 3, lithium, has an atomic weight of about 7. Now it has been found that in general among the elements of low atomic weight, the elements of even atomic number, beginning with helium, seem to be built up from helium atoms, and therefore may be said to have the general formula nHe′, where the prime is added to indicate that these elements are intra atomic, not chemical, compounds. The odd numbered elements, beginnig with lithium, seem in general to have the formula nHe′ + H_2′. Thus the elements seem to fall into two series which may be called the *even* and the *odd* series, or the helium and the lithium series, if each series is named for its first member. However, it should be noted that while the formula for the helium series is nHe′, that for the lithium series is not nLi′.

If the theory is correct it might be expected that some characteristic of the elements could be found, with respect to which there is a difference from odd to even and from even to odd, or in other words, the elements should show variations in periods of 2 elements each.

In order to have a basis for the comparison of the elements in the study of this problem there has been constructed in space a periodic model of which Fig. 1 is a drawing. In this model the elements are represented by balls strung on a spiral in the order of their atomic numbers,

which have recently been found to be much more characteristic of the elements than their atomic weights. The spiral is so arranged that the balls representing the elements belonging to one group and having the same maximum valence are strung on the same vertical rod. The balls are set at such heights that the vertical distance from the top down represents the atomic weight. This is essential, for otherwise the different kinds of atoms of one element, called by Soddy "isotopes," cannot be represented. Thus in the lower right-hand part of the table, on the lower part of Group 4B, the element lead is represented by 6 isotopes, with the atomic weights listed, as follows: lead from radium (uranio-Pb), 206.1; lead, 207.2; lead from thorium, 208.1; radium D, 210.1; thorium B, 212.1, and radium B, 214.1. Thus the different kinds of lead, which seem identical chemically and give the same spectrum, have atomic weights which differ by as much as 8 units, or by 4 per cent. However, all of these isotopes have the same atomic number, 82, or according to the theory developed by various investigators, they have the same positive nuclear charge.

When arranged in this form of periodic table the elements other than hydrogen and helium are found to arrange themselves in periods as follows:

1. First short period	Ll	— Ne:	$8 = 2 \times 2^2$ elements	Cycle		
2. Second short period	...Na	— A :	$8 = 2 \times 2^2$ elements	$1 = 4^2$		
3. First long period	......K	— Kr:	$18 = 2 \times 3^2$ elements	Cycle		
4. Second long period	.....Rb	— Xe:	$18 = 2 \times 3^2$ elements	$2 = 6^2$		
5. First very long period	. .Cs	— Nt:	$32 = 2 \times 4^2$ elements	Cycle		
6. Second very long period.Eka	— Cs:	— (incomplete		$3 = 8^2$		

It is thus seen that these periods and cycles make up a numerical system of a remarkably simple form, and it seems evident that this system must express something inherent in the structure of the atoms. However, what it is desired to emphasize here is that nearly all of the physical properties of the elements vary in periods which are either the same or nearly the same as these. The chemical properties also vary in rather long periods, which in the case of the short periods 1 and 2, are identical with those given.

From this it is seen that both the chemical and the phys-
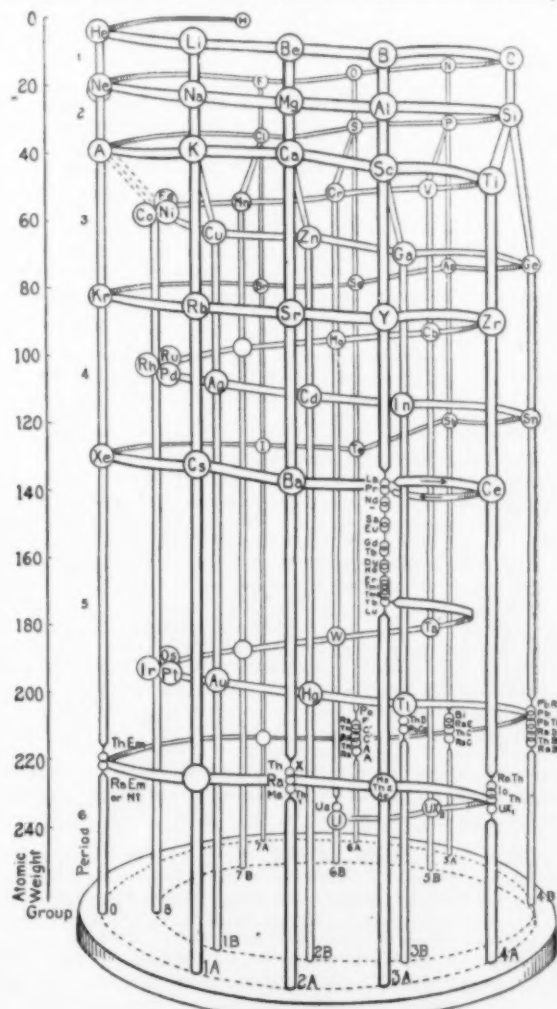
Periodic Table by W. D. Harkins

ical properties of the elements vary in periods which are long in comparison with the change in periods of 2 elements as indicated by the division of the elements into the odd and even series. If now neither the physical nor the chemical properties vary according to these extremely short periods, what, it may be asked, is left which can so vary?

Now it might easily be shown that the hydrogen-helium system of the structure of the elements, which divides them into the odd and even series, is in reality more directly applicable to the structure of the nuclei of the atom than to the atom as a whole. If then the Rutherford theory that the nuclei of atoms are extremely minute, is used as a basis for reasoning, it would be expected that the variation in the structure of the nuclei should not cause variations in the properties of the elements except in so far as they influence the nuclear charge. This nuclear charge has been assumed to be equal to the atomic number, and therefore rises with perfect regularity from odd to even or from even to odd. It seems probable that the number of electrons external to the nucleus is equal to the nuclear charge, and that it is the change in their number and arrangement which causes the physical properties to vary according to the periods listed above. This question has been discussed in a previous paper. (Jour. Am. Chem. Soc., Vol. 38, pp. 186, 203, 281.)

It might be expected, however, that the composition of the nucleus should affect its own stability, which from radioactive evidence means the stability of the atom. From this standpoint it might be reasonable to suppose that the atoms of one of the series, the even or the odd, should be more stable than those of the other. Now unfortunately there is no known method of testing the stability of the lighter atoms, but it might seem, at least at first thought, that the more stable atoms should be the more abundantly formed, and to a certain extent this is undoubtedly true. If then, at the stage of evolution represented by the solar system, or by the earth, it is found that the even numbered elements are more abundant than the odd, as seems to be the case, then it might be assumed that the even numbered elements are on the whole the more stable. However, there is at least one other factor than stability which must be considered in this connection. The formula of the even numbered elements has been shown to be nHe′, which may be written $n(4\mathrm{H}')'$. Now, since the formula for the odd numbered elements is nHe′ + H′$_3$, or $n(4\mathrm{H}') + \mathrm{H}_3'$, it is evident that, if the supply of H$_3$ needed by the elements was relatively small at the time of their formation, not so much material would go into this system. This would be true whether the H$_3$ represents three atoms of hydrogen or one atom of some other element. With regard to the latter alternative, it is at least remarkable that the H$_3$ occurs 11 times in the system for the first 27 elements, while H, and H each occur only once, and it may also be mentioned that Fabry and Buisson[2] have by interference methods determined the atomic weight of nebulium to be 2.7, and this they think indicates that its real atomic weight is 3. Also, Campbell has found that in the nebula N. G. C. Index 418, situated in the southern part of the constellation of Orion, the nebulium spectrum is found farther from the interior than that of helium, while the hydrogen spectrum extends out to a much greater distance still. This, he thinks, indicates that the atomic weight of nebulium lies between the values for hydrogen (1) and helium (4).

In studying the relative abundance of the elements the ideal method would be to sample one or more solar systems at the desired stage of evolution, and to make a quantitative analysis for all of the 92 elements of the ordinary system. Since this is impossible, even in case of the earth, it might be considered that sufficiently good data could be obtained from the earth's crust, or the lithosphere. However, it seems probable that the meteorites represent more accurately the average composition of material at the stage of evolution corresponding to the earth than does the very limited part of the earth's material to which we have access. At least it might seem proper to assume that the meteorites would not exhibit any special fondness for the even numbered elements in comparison with the odd, or vice versa, any more than the earth or the sun as a whole, at least not unless there is an important difference between these two systems of elements, which is just what it is desired to prove.

A preliminary study of the most recent analyses of meteorites of different classes showed that, either for any one class or for the meteorites as a whole *the even numbered or helium system elements are very much more abundant than those of the odd numbered or lithium system.* For a more detailed study use was made of the data collected by Farrington,[3] who suggests that the average composition of meteorites may represent the composition of the earth as a whole.

The results obtained by averaging the analyses of 318 iron and 125 stone meteorites, 443 in all, show that the first seven elements in order of abundance are iron, nickel, silicon, magnesium, sulphur, and calcium; and not only do all of these elements have even atomic numbers, but in addition they make up 98.6 per cent of the material of the meteorites. Of the remaining elements present to a great enough extent to have an appreciable effect upon the percentage values, 7 are odd and 5 are even, but in all only 1.22 per cent or odd numbered, while 98.78 per cent are even.

Of the iron meteorites 99.22 per cent of the material is made up of even numbered elements, and of the stone meteorites, 97.50 per cent. While the results for the earth's lithosphere are not so striking, they still show the same general tendency very strongly; for, of the six most abundant elements, only aluminum is odd numbered, and the elements of even atomic number make up about 86 per cent of the material. The only odd numbered elements other than hydrogen present in the lithosphere in amounts over 0.2 per cent are aluminum, sodium, and potassium.

Table 1 gives the average composition of iron and stone meteorites, arranged according to the periodic system. The numbers before the symbols represent the atomic numbers and the numbers underneath give the percentage of the element. It will be noted that *the even numbered elements are in every case more abundant than the adjacent odd numbered elements.* The helium group elements form no chemical compounds, and are all gases, so they could probably not remain in large quantities in meteorites. For this reason, and also because the data are not available, the helium or zero group is omitted from the table. The only criticism which could be made of the system of averaging, which is that of including all accurate analyses, is that it that is places undue emphasis upon the iron as compared with the stone meteorites. However, since the two relations shown in Table 1 are true for each class of meteorites separately it is evident that they will be true whatever system of averaging may be chosen.

TABLE I—AVERAGE COMPOSITION OF METEORITES ARRANGED ACCORDING TO THE PERIODIC SYSTEM

Series	Group Odd 1	Group 2 Even	Group 3 Odd	Group 4 Even	Group 5 Odd	Group 6 Even	Group 7 Odd	GROUP 8		
								Even	Odd	Even
2				6C 0.04%		8O 10.10				
3	11Na 0.17%	12Mg 3.80%	13Al 0.39%	14Si 5.20%	15P 0.14%	16S 0.49%				
4	19K 0.04%	20Ca 0.46		22Ti 0.01		24Cr 0.09	25Mn 0.03	26Fe 72.06	27Co 0.44	28Ni 6.50
	29Cu 0.01									

If attention is now turned to the heavier elements as shown in the model, it is seen that the five unknown elements eka-cæsium, eka-manganese 1, eka-manganese 2 (dwi-manganese), eka-iodine, and eka-neodymium, have odd atomic numbers. (There is some doubt as to the discovery of thulium 2.) Not only are the unknown elements odd numbered, but among the radio-active elements, if the most stable isotope of each element is used for the comparison, the odd numbered elements are much less stable than the adjacent elements of even number.

If we consider the rare-earths—the elements which are most similar chemically, while at the same time their atomic numbers change in steps of one—the same result is ob-

TABLE II

Atomic Number	Abundance	Element	Atomic Number	Abundance	Element
55	c	Cæsium	63	rr	Europium
56	ccc	Barium	64	r	Gadolinium
57	c	Lanthanum	65	rrr	Terbium
58	cc	Cerium	66	r	Dysprosium
59	r	Praseodymium	67	rrr	Holmium
60	c	Neodymium	68	r	Erbium
61	rrr	Unknown	69	rr	Thulium
62	c	Samarium	....	....	....

tained. In table 2, which includes, besides the rare-earths a number of elements adjacent to them, the latter *c* indicates common in comparison with other elements in the table, and *r* indicates rare; *cc* represents very common, etc. The comparison is only a rough one, but it is sufficiently accurate for the purpose for it indicates that in every case the even numbered element is more abundant than the adjacent odd numbered element.

The above results may be summarized by the statement that in the evolution of the elements much more material has gone into the even numbered elements than into those which are odd, either because the odd numbered elements are less stable, or because some constituent essential to their formation was not sufficiently abundant, or both.

It is easy to see too that most of the material has been used up in the formation of the lighter elements. Table 2 shows that in the meteorites the most aboundant elements are oxygen in series 2, the elements of series 3 except neon, and the members of the first eighth group tried (iron, cobalt, nickel). Clarke has found that just these same elements are the most abundant in the lithosphere, although in the lithosphere potassium and calcium in series 4 are also moderately abundant. If the lithosphere were considered alone it might be considered that the abundance of these elements is due to changes which have taken place in the lithosphere, or to the rising to the surface of the lighter elements, but these objections are not so valid when the meteorites are found to show the same relations.

In the three classes of material, the lithosphere, the stone meteorites, and the iron meteorites, in spite of variations in density from 2.5 to 8, the same two rules are found to hold, that (1) the even numbered elements, and (2) the elements of low atomic number and low atomic weight, are the elements which occur in abundance.

If an artificial line of division is made so as to classify the first 29 elements as of low atomic number and atomic weight, and the remaining 63 elements as of high atomic weight, then the following table, based upon data from analyses listed by Farrington and Clarke may be presented to emphasize the importance of the former class.

TABLE III—PROPORTION IN VARIOUS MATERIALS OF THE ELEMENTS OF LOW ATOMIC NUMBERS

Material	PERCENTAGE OF ELEMENTS WITH ATOMIC NUMBERS	
	1-29	30-92
Meteorites as a whole	99.99	0.01
Stone meteorites	99.98	0.02
Iron meteorites	100.00	0.0
Igneous rocks	99.85	0.15
Shale	99.95	0.05
Sandstone	99.95	0.05
Lithosphere	99.85	0.15

It may be said that, so far as the abundance of the elements goes, the system seems to play out at the end of the first eighth group in the periodic system. It may be of interest to note here, what has been pointed out in former papers, that it is just at this point in the system that the atomic weights cease any longer to be very close to whole numbers, as they are for the lighter weight elements. Also just at this point the exact formula given for the atoms ceases to hold well. These facts do not mean, however, that the system fails beyond the iron group of elements; for it is just among the heaviest elements that it received its verification by the actual decomposition of the elements into helium.

Dr. **Wm. J. Humphreys** of the U. S. Weather Bureau, Washington, reviewed the history of "the relation of magnetism to the structure of the atom." He emphasized that it was the Zeeman effect that had verified the hypothesis of the existence of the electron, and had shown beyond a doubt that electrons are common constituents of all atoms.

Prof. **Albert P. Wills** of Columbia University in his paper on "the relations of magnetism to molecular structure" pointed out that the magnetic properties of gases had not been investigated thoroughly as yet, and offered a very interesting field for research.

Dr. **Irving Langmuir** of the General Electric Co., Schenectady, N. Y., read a paper on "the structure of solids and liquids." He had found that in the case of a tungsten-thoria filament the surface film was 1 atom deep. In general, we can conclude that the substance on the surface decides more or less how the substance as a whole is going to behave. (See Nichols' medal paper, this journal, Vol. 13, p. 244, 1915.)

DISCUSSION

Prof. Wm. Duane of Harvard referred to the remarkable results recently obtained by the use of X-rays, and discussed the determination of wave lengths of X-rays.

In the absence of Prof. J. M. Nelson of Columbia, Dr. K. G. Falk presented his note on "chemical valence and the Grignard reaction." Dr. Falk also presented Prof. L. W. Jones' paper on "a case of chemical isomerism resulting from a difference in distribution of valence electrons."

E. D. Adams pointed out that where our knowledge is still very meager is in regard to the relation between electricity and matter.

Albert C. Crehore discussed the action of one electron upon another. Professor Swan in his usual animated style discoursed on the analysis of a single electron. Prof. A. G. Webster gave a brief summary of our present knowledge of the structure of the atom and was delighted to see the chemists and physicists get together on this most vital subject.

Professor Pupin closed the discussion, emphasizing that he was glad to see the introduction of a rotary electron into our theories. He favored rotation for years. At present we are literally swamped with new theories of the structure of the atom, but sooner or later the various ideas advanced by physicists and chemists from all over the world would be brought together into one co-ordinate whole.

Chemical Session

The chemical session of December 28 was held at the College of the City of New York, Professor Julius Stieglitz being in the chair. Dr. **Phoebus A. Levene** of the Rockefeller Institute spoke on "the individuality of tissue elements." Within recent years there have been three great achievements in clearing up the relation between chemical structure and the phenomena of life.

First, is the discovery of Dr. Loeb that the permeability of membranes of cells to potassium salts is not a constant, being dependent upon the concentration of the potassium salts. Second, is the discovery that the function of growth is a function of amino-acids having a very definite structure. Third, is the discovery that there is a specificity peculiar to species (hereditary) acid a specificity of mendelian nature (color, etc.).

There are three distinct classes of chemical compounds now known to biologists: (1) The nucleic acids, which occur everywhere, are indispensable to growth, but are not carriers of individuality. (2) The hormones, which are the carriers of Mendelian characteristics. (3) Proteins, the carriers of heredity of species. Our knowledge of these is still very incomplete.

Prof. **William McPherson** of Ohio State University discussed "asymmetric syntheses and their bearing upon the doctrine of vitalism." He reviewed the work of the early investigators, Wöhler, Pasteur, Wislicenus, Van't Hoff, and others. We still lack a good explanation of the fact that nature's products, such as sugars, are always active, either d or l, whereas our laboratory products are, as a general rule, inactive. A number of "explanations" have been offered, but the underlying

reason for this difference between the natural and artificial products is still not thoroughly understood.

Dr. **Hugh S. Taylor,** Princeton University, discussed "the photochemistry of the chlorination processes." This was a theoretical paper, based on observations made by the author in the Bodenstein laboratory at Hannover a few years ago. The general formulas may be written as follows, (—) meaning an electron:

$$Cl_2 + light = Cl_2^+ + (—)$$
$$(—) + Cl_2 = Cl_2 \cdot$$
$$Cl_2 \cdot + H_2 = 2HCl + (—)$$
$$(—) + O_2 = O_2 \cdot$$
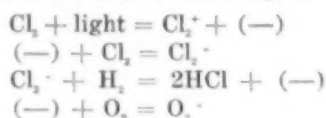
It is necessary that both the chlorine and the hydrogen are exposed to the light rays simultaneously.

Dr. **Saul Dushman** of the General Electric Co., Schenectady, N. Y., discussed the "application of atomic theories in chemistry." He discussed statistical mechanics, law of probability, Brownian movements, and Maxwell's distribution law.

Dr. **Geo. F. Kunz** made a brief announcement regarding the chemical preparedness exhibit at the Museum of Natural History.

Professor Stieglitz then asked Dr. Herty to take the chair. Dr. Herty read a telegram just received from Secretary Parsons stating that Pofessor Stieglitz has been elected president of the American Chemical Society, to succeed Dr. Herty.

Prof. **M. T. Bogert** of Columbia University discussed "the National Research Council." He gave a brief outline of the aims and purposes of the Council, emphasizing that the Council was not going to direct research, but merely aid. Ten thousand dollars has already been subscribed for the maintenance of a central office, where information of a scientific nature will be obtainable. He concluded with reading the names of the members of the Council.

Dr. **C. G. Derick,** Buffalo, discussed "equilibrium constants and chemical structure." He demonstrated how the principles of physical chemistry, when applied to organic chemistry, are productive of very important results. As a typical example, he recited his experiment on esters. If the ionization constant for acetoacetic-ethyl ester is K_1, that of acetylacetone K_2, and that of benzoyl acetic ethyl ester K_0, then

$$K_n = \frac{k_1 \times k_2}{k_0}$$

The calculated values for k_n are 0.246 (25°) and 0.234 (40° C.), whereas the values determined by actual measurement are 0.287 and 0.233 respectively.

Dr. **F. G. Wiechman** discussed the "increased sugar content of the sugar beet after removal from the soil." Due to the action of enzymes, a part of the starch in the beet will be transformed into sugar after the tops have been removed. Wiley and Maxwell (1893) had found an increase of 14.2 per cent. Similar results were obtained with barley in Germany. Wiechman has applied this principle practically. In one of the first tests, 500 lb. of beet cossettes were stored at a temperature of 132 deg. F. The net increase after seven days was 5.31 per cent in the sugar content of the cossettes.

Dr. **Edgar Graham** discussed "conductivity measurements in oxidation and reduction reactions." In the determination of the acidity of wines, etc., where ordinary indicators fail, Graham has found that conductivity measurements gave very reliable analytical results. Upon the gradual addition of standard alkali solution the conductivity (due principally to the H ion) of the solution dropped very rapidly until the end point

was reached. Further addition of alkali did not alter the conductivity values very much. By plotting the values the end point can readily be located.

M. L. Crossley discussed "valency and valence." Valency is the result of chemical reactions. For example, in the reaction

$$CH_4 + Cl_2 = CH_3 Cl + HCl$$

Ch_3 (in $CH_3 Cl$) has a valency of one as a result of the reaction. The paper brought out animated discussion by Messrs. Dushman and Taylor. Dushman objected seriously to the term "dynamic instability" which Crossley had used.

Prof. **Gustav Egloff** and **R. J. Moore** of Columbia University, discussed "decomposition of paraffine hydrocarbons." As we proceed from the low fractions C_1-C_{12}, C_5-C_{20}, and C_{12}-C_{15} to the higher boiling fractions we find that at a certain temperature, e. g. 700 deg. Centigrade the C_{12}-C_{15} fraction is more stable than those immediately preceding or following.

On Thursday evening a session was held at the Museum of Natural History, where Prof. **Arthur A. Noyes** presented a paper on the fixation of nitrogen. He gave an outline of the successful processes, figures on annual consumption, and data on utilization in arts and industries.

A reception in Philippine Hall closed the chemical meeting.

American Physical Society

Meetings of the American Physical Society, jointly with the A. A. A. S., were held on Tuesday, Thursday and Friday, Dec. 26, 28, 29. Among the forty papers presented, the following will be of particular interest to our readers:

S. Leroy Brown, University of Texas, A new calorimetric resistance thermometer.

Arthur S. King, Mt. Wilson Solar Observatory, California, Experiments with the electric furnace on the anomalous dispersion of metallic vapors.

P. W. Bridgnan, Harvard University, The effect of pressure on the resistance of metals and a possible theoretical explanation.

H. L. Dodge, State University of Iowa, The effect of temperature upon the Young's modulus of tungsten wire.

A. W. Hull, Schenectady, N. Y., The internal structure of the atom.

The address of the retiring chairman of Section B (Physics) of the A. A. A. S., Dr. A. Percival Lewis, University of California, dealt with "recent progress in spectrometry," with special reference to its relations to the structure of matter. It is published in full in *Science*, Dec. 29, 1916.

Program of Meeting for Presentation of Perkin Medal

The New York Section of the Society of Chemical Industry will hold its meeting for the award of the Perkin Medal to Dr. Ernst Twitchell on Friday evening, Jan. 19, at the Chemists' Club. The program is as follows:

Introductory Remarks ....The Chairman
Presentation of the Perkin Medal and Address
...............................Charles F. Chandler
Acknowledgment by the Recipient.....Ernst Twitchell
The Twitchell Process in the Glycerin Trade
.....................................A. C. Langmuir
The Twitchell Process in the Soap and Candle Industry ....Martin H. Ittner

The Niagara Power Situation

The following joint resolution, authorizing the Secretary of War to issue temporary permits for additional diversions of water from the Niagara River, has been passed by the House of Representatives:

"Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, that the Secretary of War be, and he is hereby authorized to issue permits revocable at will for the diversion of water in the United States from the Niagara River above the falls for the creation of power, to individuals, companies, or corporations which are now actually producing power from the waters of said river, in additional quantities, which, with present diversions, shall in no case exceed the capacity of the generating machinery of the permittee and tenant companies now installed and ready for operation, nor an amount sufficient to enable the permittee to supply the now existing hydroelectric demands of the individuals, companies, or corporations which said permittee and tenant companies are now supplying, but not in excess of the capacity of power-using appliances of said consumers now installed and ready for operation: *Provided*, that in no event shall the total quantity of water diverted *in the United States* from said river above the Falls for power purposes exceed in the aggregate a daily diversion at the rate of 20,000 cubic feet per second: *And provided further*, that this resolution shall remain in force until the *fourth* day of *March*, nineteen hundred and seventeen, and no longer, at the expiration of which time all permits granted hereunder shall terminate, unless sooner revoked; and nothing herein contained shall be held to confirm, establish, or confer in or upon any such permittee any right in or to the water which he is now diverting or which he may be authorized to divert hereunder."

The words in italics are the amendments the Senate would not agree to (the Senate proposing "the first day of July" instead of "the fourth day of March"). This throws the whole proposition into a conference committee of the Senate and House.

* * *

Representative Huddleston has introduced a bill (H. R. 19733) proposing a Niagara Power Commission of three members subject to the general supervision of the Secretary of the Interior. The salary to be $6,500 for the chairman and $6,000 for each of the other two members. Its business is to be the production of hydroelectric energy from waters diverted from the Niagara River and its distribution. The power is to be limited to the limit fixed by the treaty between the United States and Great Britain.

"The said Niagara Power Commission shall transmit and distribute, in the United States only, hydroelectric energy to municipalities and consumers convenient to its works and lines, justly and without unreasonable discrimination and as nearly as may be at the cost of delivery plus reasonable charges to cover the expenses of its operations, including the salaries of the commissioners, and plus such further annual charges as will be reasonably sufficient to discharge all of the obligations of said Niagara Power Commission so as to leave same free from debt at the end of a period of fifty years: *Provided*, That no distribution or sales of electric energy shall be made for consumption within the corporate limits of any municipality which may be able, willing and ready to assume the distribution of same therein.

"Said Niagara Power Commission shall use said waters at an efficient head and with reasonable economy, and shall pay into the Treasury of the United States for all hydroelectric energy which may be generated from said waters at the rate of $1 per annual horsepower, and no taxes shall be levied upon or collected from it by any State on account of the rights and franchises granted hereby.

"Said Niagara Power Commission may contract with one or more concerns now using said waters for generating hydroelectric energy for supplying said Commission with such energy for not exceeding five years next after the approval of this Act at a reasonable charge, not exceeding $15 per annual horsepower, such energy when so supplied to be distributed by said Niagara Power Commission as provided by Section 6 of this Act.

"No waters shall be diverted in the United States from said Niagara River above, at, or below the Falls thereof for the purpose of generating hydroelectric energy except by said Niagara Power Commission, and each act of such diversion shall constitute an offense and be punishable by fine of not more than $5,000: *Provided*, that said Niagara Power Commission may license and authorize such diversion for not more than five years after the passage of this Act for an annual charge or fee of not less than at the rate of $75 per cubic foot-second.

The Tariff and the Business Commissions

Edward N. Hurley, chairman of the Federal Trade Commission, has resigned from that body, to take effect Feb. 1, with the result that there are now practically two vacancies on the commission which the President must soon fill. Commissioner Rublee has never been confirmed by the Senate, because Senator Gallinger has said Mr. Rublee is "personally obnoxious" to him, Senatorial courtesy allowing the Senator from New Hampshire to prevent the confirmation.

In this connection it is reported in Washington that President Wilson is considering the names of a number of men who would make suitable appointees on both the Federal Trade Commission and the new Tariff Commission, and that he may be expected to announce the names of the latter commissioners shortly. Almost the same type of man is wanted for both commissions.

There is much speculation in Washington concerning the prospective commissioners on these two bodies, and in regard to tariff matters. Secretary McAdoo and the Ways and Means Committee of the House are searching for many additional articles to tax, in the form of tariffs or otherwise, owing to the big deficit in the public funds. The tariff commission when appointed will have much to say on these matters. It was proposed in Washington Wednesday that a tax be placed on business profits in excess of an 8 per cent dividend. This would be a tax of 5 per cent and would yield, it is estimated, about $200,000,000. Among other items which the Secretary of the Treasury and the Ways and Means Committee of the House are considering are the following: One dollar per horsepower on internal combustion engines, automobiles, $30,000,000; an output tax on petroleum, copper, aluminium and pig-iron, by the pound, $81,000,000; 10 per cent on crude rubber, $15,000,000.

There is a movement on foot in Washington to bring about a method of commissioners serving permanently as chairmen of their bodies, rather than to have the office of chairman rotate as is done in the Interstate Commerce Commission and as was recently done in the Federal Trade Commission. There is a feeling among some public men that the chairman of every Federal commission should be designated by the President. It is claimed that no private corporation could be run successfully without a single and fairly permanent directing head.

The movement to have chemistry represented on the Tariff Commission which we heartily recommended editorially in our issue of Dec. 1, 1916 (page 611), is spreading. Mr. Ellwood Hendrick who had been recommended to President Wilson for a place on the commission by the directors of the American Chemical Society and of the American Electrochemical Society, has since been also endorsed by the Chemists' Club, the American Institute of Chemical Engineers, the Manufacturing Chemists' Association of the United States, the American Pharmaceutical Association, the National Wholesale Druggists' Association, the National Association of Manufacturers of Medicinal Products, and the Technical Association of the Pulp and Paper Industry.

Some Production Statistics for 1916

Gold.—The gold production for 1916 as estimated by the Geological Survey was 4,465,807 fine ounces valued at $92,316,400, which is a decrease of $8,719,300 from 1915. California was the leading producer, with over 1,000,000 ounces. Colorado and Alaska were the next in importance, Colorado being but little behind California.

Silver.—There were produced in 1916 about 74,961,-000 fine ounces of silver, being a decrease of 2,077,275 fine ounces, according to the Geological Survey. There was, however, an increase in value of $10,560,000, the average price being $0.658. Montana was the leading producer, with Nevada, Utah and Idaho running close in the order named.

Copper.—A new record was established in the production of copper. The smelter output, as estimated by the Geological Survey, was 1,928,000,000 lb. and the refinery production 2,311,000,000 lb. The increase in smelter production over 1915 was 540,000,000 lb. and the increase in refinery production was 677,000,000 lb. It is estimated that with additions now being built our refineries can turn out 2,500,000,000 lb. this year if it is required. The American Metal Market Report estimates the supply on hand Jan. 1 at 82,429,666 lb. With exports of 760,000,000 in 1916 this leaves 1,633,429,666 lb. available for home consumption in 1916. Deliveries to consumers are estimated at 1,550,000,000 lb., but how much of this was actually used is not known.

Lead.—A new production was made in lead with 579,600 tons, a gain of 29,500 tons over 1915. There was a decrease of 29,000 tons in the exports of lead of foreign origin and an increase of 21,000 tons in exports of domestic lead. There were 471,200 tons available for home consumption as compared to 426,751 tons in 1915.

Tin.—The production of primary tin direct from ore became a new industry in this country in 1916. The two producers, both of which smelted foreign ore (chiefly Bolivian) turned out over 2000 tons, and the industry should become well established within another year or two. It depends, of course, upon a foreign supply of ore.

Spelter.—The production of spelter from domestic ore in 1916 was 553,000 short tons and from foreign ore 105,000 tons, according to the Geological Survey. Exports were 210,500 tons, and domestic consumption 445,000 tons. The increase in production amounted to 34 per cent, while the exports increased 59 per cent and domestic consumption 22 per cent.

Iron.—Estimates of shipments of iron ore from the mines in 1916 are 75,500,000 gross tons, compared to 55,493,100 tons for 1915. About 49,000,000 tons of pig iron were produced, compared with 29,916,213 tons in 1915.

Quicksilver.—Quicksilver was produced to the extent of 28,942 flasks of 75 lb. each, valued at $3,643,800. This was the greatest output since 1905. The figures show an increase of 38 per cent in quantity and 99 per cent in value over 1915.

Chromite.—Two years ago only one small mine in the United States was producing chromic iron ore. This was in Shasta County, Cal. The output in 1914 was less than 1000 long tons. In 1915 it increased to 3281 tons and in 1916 to over 35,000 tons, according to Geological Survey estimates. It comes from California, Oregon, Wyoming and Maryland. The imports were 88,801 long tons during the first ten months.

Petroleum.—Preliminary estimates of the Geological Survey indicate that 293,300,000 barrels of crude petroleum was produced and marketed in 1916. This is 4 per cent greater than the record-breaking year of 1915. It is estimated that 38 per cent came from the Oklahoma-Kansas field and 30 per cent from California.

Coke.—The coke output of the United States broke all records in 1916. More than 35,000,000 tons of beehive coke was manufactured, an increase of over 27 per cent compared with 1915, and 500,000 tons more than the record-breaking total in 1910. By-product coke amounted to 19,200,000 tons, an increase of more than 5,000,000 tons, or 36 per cent, compared with 1915. The total coke production, according to estimates, was 54,300,000 tons, an increase over 1915 of 12,700,000 tons, or 30 per cent.

Coal.—Coal production records were smashed in 1916, when the output was around 597,500,000 tons, compared with 570,000,000 tons, the previous high record established in 1913. The quantity of bituminous coal mined was 509,000,000 tons, an increase compared with 1915 of 66,500,000 tons, or 15 per cent, according to the Geological Survey. The quantity of Pennsylvania anthracite was about 88,312,000 net tons, a decrease of 600,000 tons.

Cement.—Shipments of Portland cement in the United State in 1916 approximated 94,508,000 barrels, an increase over 1915 of more than 7,500,000 barrels, the heaviest shipments in the history of the industry. Production, while it did not keep pace with shipments, reached a total of about 91,194,000 barrels, an increase of more than 5,000,000 barrels over 1915, while stocks fell off more than 3,000,000 barrels.

Lime.—Estimates indicate a total marketed production of 4,150,000 short tons of lime in 1916, or a gain of 15 per cent. This is a new high record. The marketed production of hydrated lime was 710,000 tons, a gain of more than 13 per cent.

The Chemical Industry of Switzerland

Switzerland is one of those countries which, although covered by a vast area of mountainous terrain, is exceptionally poor in all kinds of mineral resources. The main raw materials, coal and iron, are practically lacking, and necessitate their importation from the surrounding nations. Water power is, however, available and is being developed to its full capacity. Hydroelectric power plants have been and are still being built in all sections of the country, where the waters of the swiftly flowing mountain streams justify the investment. The war has to a great extent thrown this small country on its own resources as far as the power question for industrial purposes is concerned, but at the best this power source is insufficient to supply the 107 chemical

plants at present in operation in Switzerland. The bulk of the coal, therefore, at present is obtained from Germany. Previous to the war coal was also imported from France.

Switzerland is blessed with at least two universities, whose chemical engineering departments are ranked with the best in the world. These institutions are the Polytechnikum at Zurich and the University of Zurich, both being independent of one another and financed by the government. From these two main sources come practically all the chemical engineers the country has. The engineers receive their training under men like Treadwell, Lunge, Werner, Lorenz, Vislizenius and others, all prominent figures in the field of chemistry.

The most important chemical industry is undoubtedly the manufacture of synthetic dyes. Besides this branch, Switzerland manufactures pharmaceutical products and chemicals for industrial purposes. There are two types of colors produced in Switzerland, namely, vegetable dyes, chiefly produced from logwood, and coal tar colors. The most important dye industry is undoubtedly the production of synthetic dyes. At least 106 synthetic dyes are at present produced by the various dye factories of the country. These dyes at present are mainly shipped to England and France, but would, under normal conditions, be available for the American market. A list of the colors produced may be found in the Commerce Reports for Nov. 13, 1916. The importance of the Swiss dye industry is best illustrated in the following table, giving the exports since 1896, taken from the mentioned report:

Year	Coal-Tar Colors	Vegetable Dyestuff Extracts	Tanning Extracts	Synthetic Indigo
1896	$2,580,754	$94,923	$126,770	......
1897	3,186,632	117,480	147,627	......
1898	3,259,539	98,156	135,323	......
1899	3,172,331	81,860	148,153	......
1900	2,961,173	69,576	125,347	......
1901	2,847,389	65,610	123,719	......
1902	3,081,563	73,871	141,673	......
1903	3,336,626	76,987	146,778	......
1904	3,452,436	75,732	133,064	......
1905	3,862,756	73,068	160,137	......
1906	4,209,646	72,038	142,803	......
1907	4,233,533	78,866	139,872	......
1908	3,793,836	81,538	152,419	......
1909	4,667,869	94,239	183,640	......
1910	4,905,002	99,142	223,434	......
1911	4,920,212	115,404	297,684	$72,460
1912	4,970,474	97,346	315,130	291,334
1913	4,794,960	95,987	323,782	754,792
1914	5,123,944	84,250	286,252	978,956
1915	5,585,738	94,261	289,144	434,525

Next in importance to the dyestuff industry is the manufacture of pharmaceutical preparations. Among the specialties made are protargol, collargol, itrol, a new preparation of a silver protein compound carrying 30 per cent silver and sold under the trade name of solargyl, airol, phytin, throcol, salen, benzalen, vioform, lipogodin, jodostarin and jodogallicin. Besides the above mentioned chemicals, the Swiss factories produce alkaloids, perfumes, cosmetics, and, for industrial purposes, acid potassium tartrate, boric acid, phosphoric acid, sodium, tanning extracts, glycerin, methyl alcohol, coal-tar derivatives, benzylchloride, glue and gelatin.

It is of interest to know that the first chemical factory in Switzerland was built in the year 1764. From that time up to date the number has increased to 107. The products produced in these factories are, under normal conditions, shipped to all parts of the world, while at the present time the export is mainly restricted to China, France, Italy and the United States.

Waste Heat for Steam Generating Purposes.—In our last issue (January 1, 1917) owing to a printer's error, the author's name, Mr. Arthur D. Pratt, was omitted from the concluding part of his article on "The Utilization of Waste Heat for Steam Generating Purposes."

The Human Side of the Development of Chemical Industry*

By G. W. Thompson

Numerous writers and speakers have called frequent attention to the great service which chemistry has rendered to humanity. In every field of industry she has been active, every product of man's labor has felt her magic touch. Modern civilization can be measured most accurately by considering the influence which chemistry has had upon industry and industrial operations. It is unnecessary here to tell what she has done. We are more concerned with the future than with the past, and judging the future by the past, the benefits which chemistry during the coming years will confer upon humanity will be infinitely valuable. On us, her votaries, is imposed the task of laying out the course of her progress, preparing and making the way easy for her and heralding her triumphant march. It is the purpose of this paper to indicate how this may best be done.

It should be perfectly obvious that the purpose of all industry is to satisfy the desires of human beings. This is as true of chemical industry as it is of any other industry. The chemist renders human service. He is a human being himself and his service to human beings makes him a part of a great democratic commonwealth in which every member is a factor in the development of the whole. The chemist is only a fraction in this commonwealth, but the more he is organically a part of it the greater is his power of service. Like everyone else he does not exist by himself alone, but is dependent for his existence upon every other human being that is a part of the social organism.

In the last analysis all of the relations between human beings are mental relations. The instruments of connection between human beings may be material, but the relation itself is spiritual. In so far as the chemist renders service he does so by impressing himself on other people and affecting them either directly through personal contact or indirectly through the products of labor in the fabrication of which he has had a part. Human relationship, therefore, is the end toward which we are perforce all compelled to work. Each man must impress other people and he must in turn be impressed by them. There is no such thing as independence. We are all dependent, and in seeking for what we may nominally call independence we are simply shifting our dependence from one point to another. It is foolish to talk about being independent and it is unwise to seek independence, because it cannot be obtained. Still more important than this, it is best for us that we should not seek independence, but that each one of us should seek to be dependent upon everyone else, thereby conforming to the best conception of human relationships and to the economic law according to which the best service only can be rendered.

What we propose, therefore, is that the chemist should strive against anything that would tend to isolate him and separate him from his fellowmen. What we will try to show is the means by which he can avoid these tendencies, how he may more effectively integrate himself into the social organization.

Perhaps what we have in mind can best be visualized by considering here what has been believed by some to have interfered with the growth of chemistry in this and other countries. For instance, the cry has come from England that technically educated men have not been sought for as the occupants of high official and

business positions. It has been claimed that a scientific education did not help towards social or public advancement; that in England a man with a classical education was sought after, not the scientific man. Assuming this to be so, it is perfectly clear that the advancement of the chemist in England has been retarded by a lack of public appreciation of the service which he renders or can render to the nation. What, then, is the chemist in England going to do about it? Apparently he is dissatisfied, which in itself is all right, but being dissatisfied does not alone change inexorable facts. In every chemical problem that confronts the chemist when facts stand in his way he does not get excited about them, but seeks to surmount them by careful study and the devising of ways and means. This should be the attitude of the chemist in England, and by organized publicity—advertising if you will— he should seek to change public opinion so that it will accord to him a higher recognition.

That the English chemist is taking this view is indicated by a recent address by G. G. Henderson before the Chemical Section of the British Association for the Advancement of Science, Newcastle-on-Tyne, 1916. In discussing the synthetic production of nitric acid from the air and the great advantage it would be to England, he laments that England has done nothing in the matter except to appoint a committee to consider possibilities. Then he goes on to say: "This case is only too typical of many others. A number of different causes have contributed to bring about this state of affairs, and the responsibility for it is assigned by some to the government, by others to the chemical manufacturers, and by still others to the professors of chemistry. I think, however, it will be generally admitted that the root of the matter is to be found in the general ignorance of and indifference to the methods and results of scientific work which characterize the people of this country." He adds, however, that he thinks that the English leaders in science have done all that lay in their power to awaken the country to the inevitable and deplorable results of this form of "sleeping sickness," and that he believes that a brighter day is dawning, and that if they rise to the occasion now, chemistry in that country will attain the position of importance which is its due.

Let us take another case. Germany has made great advances in chemistry. Some think that this is due to her system of education, and probably this is partly true. Some think that it is due to the far-sighted wisdom of public men. This, too, is probably partly true, but the real success of chemistry in Germany in my own opinion has been due to its greater popular appreciation. Historians have long since dropped the idea that kings and rulers in general amount to very much in the progress of a nation, and have adopted the broader conception that progress ultimately is in the people of a nation, their developing thoughts, their appreciation of the world that is about them.

The lesson to us in the United States is this—that if we wish chemistry to become a more potent factor in the industrial growth of our country we must take such steps as are necessary to bring about a popular appreciation of its value. Universities will help, government aid will help, but these too depend upon popular appreciation both in their beginning and in their execution; after all, they are mere incidents to fundamental active causes. Create a demand for universities and universities will rise, as it were, over night; create a demand for governmental interest and governmental interest will come quickly and effectively, but demand is born of popular appreciation.

Mr. Elwood Hendrick in an article that appeared not very long ago in one of our popular journals emphasized this point in urging the popularization of chemistry, and he expressed the thought that chemists would not come into what they believed to be their own until this was done. Mr. Hendrick's suggestion would indicate the advantage of chemists generally advertising their profession, not necessarily, however, in the form of paid advertisements, but in properly written articles for the popular press. The desirability of such a procedure properly carried out is fairly obvious, subject to some limitations, which we will consider further on.

As an illustration of what we can accomplish in this direction I would refer to Robert Kennedy Duncan's writings (particularly his "Chemistry of Commerce") as having been exceedingly efficient in popularizing chemical knowledge, and to the fact that Duncan's efforts in this direction probably resulted in the establishment of the Mellon Institute. As another example of a very commendable effort to popularize chemistry, I would refer to the Chemical Expositions, the second of which was held last September in the city of New York. When the first exposition was proposed, many chemists expressed a great deal of doubt as to its wisdom and practicability, but as the time approached for the opening of the exposition its value to chemists became more clearly recognized and it received from them a very generous and hearty support. So successful was the first exposition that immediately a second one was projected. This received even more generous support, and two of our largest chemical societies decided to hold meetings at the same time. The public press has been full of matter descriptive of the exposition itself and the accomplishments of chemistry thereby illustrated, and gave much space to the papers and discussions, presented at the meetings of the two chemical societies. These expositions were distinctly advertising in their character and great expenditures with the expectation of profitable return were made by the exhibitors themselves.

Our National Departments of Agriculture and Commerce have done much in popularizing chemistry. The work of Dr. Wiley started in the Department of Agriculture has extended the knowledge of chemistry in popular fields through the publication of numerous bulletins and leaflets. More recently the Department of Commerce has, through special investigators, been instrumental in increasing the knowledge of the relation of chemistry to industry. Similar work has been done to some extent by the Department of the Interior.

It seems hardly necessary that I should go further in emphasizing positive aspects of this phase of my subject. Let us consider now some of the criticisms that have been offered on work of this kind. The most general criticism is that when an attempt is made to popularize a science such as chemistry many unscientific statements will be made and true representations will often be incorrectly interpreted by the public. This is undoubtedly so. Erroneous ideas have been promulgated in this way, but the chance to err is not confined to popular presentations. We know that many errors have crept into scientific literature, necessitating laborious effort later on for their correction. To err is human, and the danger that error may occur should not act as a preventive of public statements, whether these are made in the scientific or popular press.

Another objection comes from those who hold that the profession of chemistry is of a very exalted character and that the serious chemist will not descend to ordinary popularizing effort. Our own code of ethics would prevent the chemist from advertising in a sensational manner, and requires the professional chemist to publish scientific papers in the technical journals

before they are given to the popular press. It seems to me that our code of ethics is correct in this respect. We do not want to advocate sensationalism and we do want to build up our technical journals, but after the requirements of our code have been complied with there still seems to be a field open to the chemist in which he can with perfect propriety popularize his science.

The advocates of the study of pure chemistry are also apt to look down upon this popularizing scheme. To them popular science is offensive, and it may be that some of them can hardly be expected to sympathize with the views I am here presenting. The student of pure science is, however, almost in a class by himself. The utmost that he does in affecting the world's processes is by furnishing information, studies and generalizations to be applied by the practical chemist in furthering the interests of the entire world. Far be it from me to depreciate the value of the pure scientist. We all draw upon him for help in our practical efforts. It must be admitted, however, that he lies essentially outside of the plan that we are proposing. He indulges more or less in an esoteric culture and his light, though it is not hidden, is reflected to the world at large only by those who can practically direct that light to the illumination of ordinary things. In spite, therefore, of all that may be said against the popularization of chemistry, I am still convinced of the wisdom of such a purpose, because it is only by so doing that even the student of pure chemistry will be given an opportunity to carry on his studies. So firm is my belief in this that I would extend this effort so that it would reach and include the most humble members of society.

In order to present in picture form, as it were, the dependence of the chemist for his success upon the popular appreciation of chemistry, let me present the following sketch: A chemist makes what he believes is a discovery of great financial value. If he has money enough of his own he may be able to make that discovery a source of financial profit, but in so doing he will have to be something in addition to a chemist, for the largest part of his effort will be along lines which are essentially non-chemical, involving the organization of business, the advertising of the product or process, and its sale for use. In proportion as the public is capable of appreciating what he has accomplished, to just that extent will he make a financial success. Suppose, on the other hand, this chemist is not a man of means and wants to interest financial people in his discovery. As things are to-day he will first encounter skepticism, even ridicule, and if finally he is successful in having his discovery appreciated by financial interests, it will be because he has been able to convince them of its human aspects, and it may be that before he is through a great part of the value which he has seen in his discovery will have been absorbed by what the financial interests think is their proper return. The ordinary business man of to-day very naturally thinks that his business ability is more valuable than the technical ability of the chemist. He wants the lion's share. There is no use in closing our eyes to this fact. Many a poor inventor or discoverer has been so discouraged in his early efforts for recognition that he has been almost ready to drop his entire proposition. He says the blame lies on an unappreciating public, and this is true, but if it is true, how incumbent it is upon the chemist to make the public appreciative. He can do this only by studying the public, finding wherein the public should be educated, and recognizing all its limitations, work with wisdom toward the accomplishment of his purpose.

(*To be concluded.*)

New York Meeting of American Institute of Chemical Engineers

The winter meeting of the American Institute of Chemical Engineers was opened on Wednesday, Jan. 10, in Rumford Hall, Chemists' Club, New York City, with a business meeting at 10 a. m. In the absence of the president, Dr. Rosengarten of Philadelphia, Vice-President GUSTAV W. THOMPSON, chief chemist of the National Lead Company, presided. And rightly so, for when the committee for canvassing the letter ballots for the annual election of officers (Mr. A. E. Marshall, chairman) presented its report in the evening session, Dr. G. W. Thompson was declared the new president of the Institute by unanimous vote.

The business session in the morning was devoted to the presentation of a long series of reports by the chairmen of the standing committees or in their absence by Secretary Olsen. The monotony of the presentations of committee reports was relieved by a liberal sprinkling of discussions on various angles of professional ethics. Though the Committee on Ethics had not any report of its own, there was more talk—and interesting talk—on ethics during the morning session than we have listened to for a long time.

After the close of the business meeting three papers were presented.

First, an address by the retiring president, Dr. GEORGE D. ROSENGARTEN on chemical preparedness was read by Dr. Olsen in the author's absence. It discussed the peculiar conditions of industrial unpreparedness in which this country was found after the start of the European war.

The paper was referred to the Committee on Public Relations after some discussion in which Messrs. Andrews, McKenna and Withrow participated.

Mr. H. D. MILES, president of the Buffalo Foundry & Machine Company, followed with an interesting review of recent developments in chemical engineering equipment by his company. The Buffalo Foundry & Machine Company was founded sixteen years ago on what was then a radically new basis, namely as a modern foundry on a scientific laboratory-controlled basis. Chemical castings soon became its principal products and the company soon succeeded in turning out caustic pots which had a longer life than European-made pots. Attention was then turned to the manufacture of chemical retorts, acid eggs and acid kettles, as well as vacuum dryers, pumps, and condensers.

Mr. Miles described in some detail the principles of his company's vacuum drum dryer. One of its most extensive uses has been the production of powdered chestnut and hemlock extracts, another the recovery of dry sulphite waste from the waste liquors of paper mills.

When the European war broke out, there was a sudden and large demand for chemical equipment and the Buffalo Foundry & Machine Company entered into the manufacture of equipment for various chemical industries new to this country. Mr. Miles described improvements in machinery for synthetic phenol and the use of the atmospheric drum dryer and sketched advances made in the design of a reducer for the manufacture of aniline oil and of apparatus for the distillation of beta naphthol, the construction of antoclaves for the production of dimethylaniline, the design of new denitrating apparatus for the distillation of nitric acid from a mixture of nitric, sulphuric and water. Mr. Miles finally referred to the manufacture of acid-resisting castings and mentioned the erection of a large research laboratory as the latest undertaking of his company.

A paper by Professor HERBERT T. KALMUS and K. B. BLAKE was then read by title, as printed advance copies of this paper were available. (Several of the papers were printed in advance—a novelty with this Institute and a highly commendable one.) The paper gave the results of a series of investigations extending over a period of several years of the effects on the corrosive properties produced by the addition of various amounts of cobalt, nickel, or copper to a very pure commercial iron. The investigations were made at Queens College, Kingston, Ontario. The results show in general that cobalt, nickel and copper increase the resistance to corrosion. The authors consider the phenomena of corrosion more complex than has been generally stated by the electrolytic theory.

From the authors' summary of results we quote the following:

The corrosion, or loss of weight in grams per square centimeter of original surface per hour, is the function of the length of exposure, being less for the longer exposures. This is true because of the property of these alloys to form a self-protecting layer or coating.

The alloys formed by the addition of small percentages of copper, nickel and cobalt (from 0.25 per cent to 3.0 per cent) to pure iron, are more resistant to atmospheric corrosion than the pure iron, from which the alloys were prepared.

Considering the data for alloys formed by adding various amounts of cobalt (from 0.25 per cent to 3.0 per cent) to pure iron, with very little, if any, carbon content, it is apparent that the corrosion is not a simple function of the percentage of cobalt content. In general, the corrosion of the alloys formed by the addition of 3 per cent of cobalt to pure iron is about 75 per cent as great as that of the alloys formed by the addition of 0.5 per cent of cobalt.

Alloys formed by the addition of 0.25 per cent to 3.0 per cent cobalt to pure iron, with very little, if any, carbon content, are corroded in the atmosphere to an extent varying between 50 per cent and 75 per cent of that of the pure iron from which the alloys were prepared.

These two last conclusions are approximately true for the corresponding nickel alloys as for the cobalt alloys. There seems to be very little choice between the use of nickel and cobalt to form alloys with pure iron containing between 0.25 per cent and 3.0 per cent of the added metal for the prevention of corrosion.

As corrosion progresses, all of the alloys prepared form self-protective coatings of oxides. It is noticeable throughout that the oxides formed by the cobalt are darker, denser, and more tenacious than those formed by the other alloys.

The effect of preventing corrosion of the protective coating just mentioned does not seem to have worked greatly to the advantage of cobalt alloys, in spite of its more satisfactory appearance, in the length of time that the above experiments were allowed to run.

In order to finally conclude the possible ultimate advantages of the cobalt alloy protective coating, as compared with the other sheets, all of the alloys should be allowed to corrode to destruction. The results of such tests, as are being made by the authors, will be published later.

The addition of copper to pure iron to an extent between 0.25 per cent and 0.75 per cent seems to be conducive to reducing the corrosion of the iron under atmospheric conditions. It is difficult to say whether or not the addition of copper in these amounts has a greater or lesser effect than the corresponding amounts of nickel or cobalt. Additional experiments will be required to determine these facts, but there can be but little doubt that the addition of copper, as above reported, diminishes the corrosion of the pure iron.

The amount of corrosion varies with the percentage of carbon in the alloy, as would be expected.

The paper was discussed in the evening session at great length by Dr. A. S. Cushman of Washington, who after giving a sketch of the history of American ingot iron considered that the authors' tests were inconclusive. He insisted that no conclusions can fairly be drawn from tests with such small samples. Only exposure tests with large full-size sheets give fair results. He has himself such tests going on. The use of nickel and cobalt he considered prohibitive on account of the price. He does not think that the authors' conclusion as to the effect of copper is justified. He considers standardization of quality and material (American ingot iron) to be all important.

Professor JOHN F. BUCHER, of Brown University, Providence, R. I., followed with a paper on the fixation of atmospheric nitrogen. Professor Bucher spoke extemporaneously for over two hours in a most interesting manner. As this was the first public statement of his researches (outside of several patents which were abstracted in our Vol. XII, p. 725, and Vol. XIV, p. 543) he was listened to with great attention. Two points stand out strongly. First, Professor Bucher fixes the nitrogen in form of cyanide. Second, his process does not require a large amount of power and therefore does not presuppose the availability of cheap waterpowers. It can be carried out at any place where sodium carbonate, iron and carbon are available and can be easily carried on in an emergency.

Professor Bucher reviewed former attempts to fix nitrogen as cyanide, all of which were failures, but pointed out that as early as 1837 iron was claimed to be favorable. Professor Bucher indeed found that finely divided iron as a catalytic agent is necessary. His first experiments were made in a tube furnace with the reaction

$$2Na + 2C + N_2 = 2NaCN.$$

There is some reaction, but very little. But as soon as finely divided iron is added to the graphite, the reaction became instantaneous:

$2Na + 2C + N_2 + iron = 2NaCN + iron + 52,000$ cal.
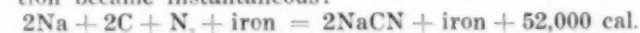
This is a fine method for getting argon for lecture experiments. The reaction is interesting in another way. If not enough carbon is provided in the mixture, the sodium vapor will absorb carbon from the iron and decarbonize it.

In the present process of the author's sodium carbonate is used instead of sodium. The reaction is

$Na_2CO_3 + 4C + N_2 + iron = 2NaCN + 3CO + iron$

$$- 134,600 \text{ calories.}$$
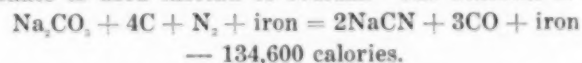
It is an endothermic reaction. The nitrogen need not be pure by any means. Producer gas works as well as nitrogen, neither better nor worse. Finely divided hematite is as good a catalyzer as finely divided iron and much cheaper. The mixture is briquetted simply with water, without any tar or pitch admixtures.

The author then turned to a sketch of the engineering development of the process. Very simple apparatus is required. A vertical tube furnace heated electrically was described (see our Vol. XIV, p. 543). Professor Bucher touched in his further remarks on a great many other researches into which he was led by the development of this process.

After the close of the session there was an enjoyable smoker tendered by the Chemists' Club.

A fuller report of the papers as well as a report of the proceedings at the Friday sessions must be reserved for our next issue.

An Investigation of the Brittleness Produced in Steel Springs by Electroplating

By M. DeKay Thompson and C. N. Richardson

The fact was called to our attention several years ago by Dr. W. H. Whitney that small steel springs become brittle when plated in copper cyanide baths. The object of the following work was to find the cause of this deterioration and under what conditions it does and does not occur.

The steel wire used in these experiments were several sizes of Edgar T. Ward & Sons' "black tempered spring wire" and piano wire.

The first experiments were to determine whether steel springs are injured by plating in a nickel bath containing no cyanide. The bath had the following composition: Nickel ammonium sulfate, $NiSO_4(NH_4)_2SO_4 8H_2O$, 70 grams; ammonium sulfate $(NH_4)_2SO_4$, 10 grams; water, 1 liter.

The pickling solution was 150 cubic centimeters of concentrated sulfuric acid in 750 of water. Short springs were made of black tempered spring wire of the following diameters in millimeters: 1.05, 1.33, 1.65. They were plated at room temperature from one to two hours with a current of from 0.2 to 0.35 amperes. Piano wire of diameters in millimeters 0.28 and 0.33 were plated until their diameters were increased to 0.45 and 0.50 millimeters respectively. The springs were apparently unaffected in any way.

A copper cyanide bath was then made up as follows: Cuprous cyanide, 35 grams; sodium cyanide, 1140 grams; water, 750 cubic centimeters.

A piano wire of 0.46 millimeter diameter was then made into a spring and was plated in this solution with 0.45 ampere. The spring was under a slight tension during the plating and broke at the end of twenty-two minutes. No copper was deposited, the current density being too low. A spring made from black tempered spring wire 1.05 millimeters in diameter was plated with 6.15 amperes and a good deposit of copper was produced. After twenty minutes the spring was removed and was easily broken by stretching.

Larger sizes of the steel and wire of other metals were not affected by plating in this solution, as shown by the following data:

Material	Diameter	Duration of Plating Minutes	Amperes
Steel	1.57	25	10
Steel	2.02	25	10
Steel	2.54	25	15
Brass	0.53	21	10
Brass	1.03	30	10
Phosphor-Bronze	0.64	27	10

None of these wires broke.

In the first experiment in cyanide solution only hydrogen and no deposit of copper was produced, and the spring became brittle. As hydrogen is known to make electrolytically deposited iron very brittle, this suggested that the hydrogen liberated might have penetrated the steel and have caused its brittleness. In order to test this steel springs were electrolyzed as cathodes in a 15.5 per cent sodium hydroxide solution as follows:

Diameter in millimeters	Duration minutes	Amperes
0.33	35	1.50
0.46	49	5.00

They were entirely unaffected, showing that hydrogen is not the cause of the trouble.

A solution of sodium cyanide containing originally no copper was next tried. As a copper anode was used to prevent the escape of cyanogen, a small amount of copper went into solution during the electrolysis. The results with steel wire were as follows:

Diameter in millimeters	Duration minutes	Amperes
0.29	38	4.5
0.46	9	7.0
1.01	60	14.0

Only the wire 0.46 millimeter in diameter broke. The conditions of the experiment did not remain constant on account of the solution of copper at the anode, causing deposition at the cathode.

A platinum anode was then used, and the cyanogen was passed into a solution of sodium hydrate for absorption. The electrolyzing vessel was a wide mouthed Erlenmeyer flask.

Springs made of 0.46-millimeter wire were electrolyzed for ten minutes with 7 amperes, one in sodium cyanide alone and the other in sodium cuprocyanide. Both were brittle, but the one electrolyzed in sodium cyanide was much more so than the one in sodium cuprocyanide.

It was also found that the wire was most brittle nearest the point of support, and that the brittleness decreased with the distance from this point. This must be due to the greater current density near the support where electrical contact is made.

It was found that the same brittleness is produced in straight wire which has not been bent or coiled. No effect is produced by mere contact with the solution. A spring made of 0.46-millimeter wire was suspended under tension for two hours in a sodium cyanide bath with no current passing. It did not become brittle.

These experiments indicate that the cyanide radical in combination with electrolysis is the cause of the brittleness. The fact that the brittleness is more pronounced in the absence of copper is probably due to the protection the steel gets from the layer of copper deposited. This suggested that the brittleness might be due to a kind of case-hardening by the cyanide radical. These experiments were all at less than 100 deg. C., and such an effect at this temperature seemed very improbable. It was, nevertheless, tested by analyzing the wire for carbon before and after it had been made brittle. The chromic acid method was used (Treadwell-Hall, 1914 edition, page 391). The following results were obtained:

Per Cent Carbon Before Electrolysis	After Electrolysis
0.70	0.73
0.78	0.65
Av. 0.74	0.69

As these check within the limits of the accuracy of the analysis, this suggested case-hardening effect does not take place. This wire was 0.46 millimeter in diameter and was electrolyzed at 80 to 85 deg. C. with 3.5 amperes for one hour and fifteen minutes. The electrolyzed wire was brittle.

There seemed nothing left to explain the brittleness except a possible change in the crystalline structure of the steel. This was therefore examined next.[1]

In order to get a polished cross-sectional surface, several pieces of wire were clamped between brass strips, with the ends projecting a little beyond the brass. These were then ground down flush with the brass, and the whole surface, brass and steel, was polished with rouge. The surfaces were etched with a 4 per cent solution of nitric acid in alcohol. The structure of the steel before and after electrolysis did not show any differences.

As all wire is drawn cold and has internal strains, it was next decided to see whether the brittleness is

still produced after internal strains have been removed. In order to remove the strains, some steel spring wire 0.40 millimeter in diameter was heated in an electric furnace as follows:

Time	° C.
11.25	740
11.45	760
12.45	500
12.45	356
1	Room temp.

700 deg. C. is the transition-temperature of 0.7 per cent carbon steel. This wire was then electrolyzed for 1.5 hours with 3 amperes at 80-85 deg. C., without producing brittleness. No difference in the structure was found. Electrolysis of wire as cathode therefore does not produce a change in the structure.

Electrolysis of the wire as anode was next tried. A spring of steel wire of 0.46 millimeter diameter was electrolyzed as anode for fifty minutes with 3.5 amperes at 80-85 deg. C. It was not made brittle.

The surface of the brittle springs and the fractures of the brittle wire were then examined with a microscope for a possible explanation. The surface of the wire showed shallow scratches parallel with the axis of the wire, doubtless caused by the die. The crystal structure could also be distinguished. The majority of the fractures of the brittle wire seemed to follow these scratches, but no further connection between brittleness and scratches was found.

As no other possible explanation of brittleness produced by electrolysis could be thought of, these experiments were for the time at least reluctantly discontinued.

SUMMARY

Though the explanation of the brittleness produced in a spring wire when used as a cathode in a hot cyanide solution could not be found, the following results were obtained:

1. Spring steel becomes brittle when used as cathode in a hot cyanide solution, either sodium cuprocyanide or simply sodium cyanide. The effect is more pronounced with the simple salt. Brass and phosphor-bronze are not affected.

2. Brittleness was not produced by the liberation of hydrogen on the steel.

3. The carbon content is not changed by the electrolysis.

4. The crystalline structure is not changed by electrolysis.

5. The brittleness is not produced in annealed wire.

6. The brittleness is produced by use as cathode whether the wire is coiled or not bent in any way.

7. The brittleness is not produced when the wire is used as anode, or when it is suspended in the solution without the passage of electricity.

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The **Minerals Separation North American Corporation** has been organized under the laws of Maryland with 500,000 shares, having no par value, by the Minerals Separation Co., Ltd., of England, to handle the latter's business in North America. The new company will take over all the assets and business of the Minerals Separation American Syndicate which was formed in 1913 and in which Americans have an interest.

Meeting of the Teknik Club at Denver. On Dec. 12, 1916, the Teknik Club held its monthly meeting. Two papers were presented, one by Mr. Proffitt, entitled "The Use of the Polariscope in the Sugar Industry," and a second one by Mr. J. A. Hunter, "The Work of the State Bureau for the Inspection of Oils."

Analysis of Babbitt Metal; Alloys of Tin, Antimony, Lead and Copper

By E. W. Hagmaier

PREPARATION OF THE SAMPLE

Break or saw the ingots squarely across and file after removing the roughness. If care is taken an accurate sample of the cross-section can be taken. A sample may also be taken by sawing through the ingot several times and collecting the sawings. These sawings or filings should be gone over with a magnet to remove any iron which might contaminate the sample.

ANTIMONY

One gram of the filings is dissolved in an Erlenmeyer flask (800 c.c.) with 10 c.c. of water and 25 c.c. of sulphuric acid. When solution is complete and no black shows in the bottom of the flask remove from the hot plate and cool. Now add 100 c.c. of water and 10 c.c. of hydrochloric acid and boil 10 min. to expel sulphurous fumes. Cool, and add 100 c.c. of water and titrate with potassium permanganate.

TIN

Dissolve a half-gram sample in 30 c.c. of hydrochloric acid in an 800-c.c. Erlenmeyer flask, using gentle heat, and if it is impossible to get complete solution add a small amount of potassium chlorate, but add this sparingly in order not to weaken the acid too much. When solution is complete add 150 c.c. of water and 80 c.c. of hydrochloric acid. Place a strip of ingot iron in the flask and cover with an inverted crucible cover and boil for an hour, or until all the tin is reduced. Remove the flask from the plate and cool quickly; when cool remove the strip of ingot iron and titrate at once with 0.1 normal iodine solution.

LEAD

Place a convenient sample in a 250-c.c. beaker and add 5 to 15 grams of tartaric acid. The amount of this acid depends on the amount of tin in the sample, more tin requiring more of the tartaric acid. To this mixture of acid and sample add 15 c.c. of boiling water and 3 c.c. of nitric acid. When solution is complete add 3 c.c. of sulphuric acid and boil until all brown fumes cease to come off and then give about 1 min. more and remove from the plate.

Care must be taken not to boil too long after the fumes cease to come off, as the sulphuric acid will char the tartaric acid. When all fumes are off cool the solution and add 50 c.c. of water and filter off the lead sulphate, washing the precipitate with 2 per cent sulphuric acid solution. Dissolve the sulphate in hot saturated ammonium acetate solution, add 2 c.c. of acetic acid, bring the solution to a boil and add potassium chromate; boil the contents until the lead chromate settles well. Filter on a tared paper, washing well with hot water, dry at 100 deg. C. and weigh and calculate to lead.

COPPER

To determine the amount of copper treat a larger sample in the same manner as that for tin to the point where the lead sulphate is filtered off; when the lead is filtered off and the precipitate is washed so that no copper remains held in the precipitate, then discard the precipitate and add 2 or 3 c.c. of hydrochloric acid to the filtrate and several pieces of copper-free aluminium and place on the back of the plate and the copper will be thrown out of solution.

When all the copper is thrown out filter off, wash several times with hot water and redissolve the copper

in dilute nitric acid, washing the paper free from all traces of copper and determine the copper by titration or by electrolytic deposition.

COPPER TITRATION

Weigh out ½ gram of copper foil and dissolve in 5 c.c. of nitric acid; when all dissolved and all brown fumes are driven off neutralize with sodium carbonate and then make acid with (1-3) acetic acid and cool. To the cold solution add 3 grams of potassium iodide and stir until this is all dissolved. The solution will be a brown with a white precipitate.

Titrate at once with 0.1 normal thiosulphate solution with continual stirring. As the thiosulphate is run in the brown color will fade; when it is pale add 10 c.c. of a starch solution and continue to titrate until the blue color is gone entirely.

PRECAUTIONS

Keep concentrated, have slight excess of acetic acid, have completely cold before adding the iodide, add sufficient iodide, and stir continually during titration.

Buffalo, N. Y.

Vaporization of Metallic Copper in Wirebar Furnaces

By Allison Butts

The question of the vaporization of copper, silver, gold and other metals in refining furnaces is of considerable importance. It has been known for a long time that there is a loss due to this cause—similar to the evaporation of water from an open vessel at ordinary temperatures—but little has been known either of the extent of the loss or of the circumstances attending it. Some recent experiments give us more knowledge on this subject and afford the basis for some interesting theory. The latter is perhaps at present not of much practical value, but this may develop later in the light of more knowledge and experience.

The present consideration of loss by vaporization was first made in connection with refining of electrolytic copper slimes, when some experiments were made to determine the stack loss. It was found that the bulk of the loss was due to fine particles of slimes carried through the scrubber and out of the stack by the draft. However, the material which passed out of the stack during the later stages of the Doré refining process, when air was being blown into the molten bath, while less in amount was richer in gold and silver, and had the appearance of being mixed with condensed fume. This indicated that part of the loss was due to vaporization.

Any theory with regard to loss by vaporization in the silver refinery was complicated by the fact that a number of different furnaces discharged their gases into the same flue system, by the presence of the scrubber, and by the large amount of metals present as impurities, at least one of which, selenium, forms a comparatively volatile compound with silver. But in the case of other experiments made on wirebar furnaces, there was but one source of metallic vapor to consider, namely, a very pure copper bath.

Copper at the temperature of the melting furnace has an appreciable vapor pressure, and as a result a certain amount of copper vapor from the bath will become mixed with the hot gases and be carried with them into the flue. This amount will be a maximum at the "saturation point" for copper vapor, the limit depending on the temperature in the furnace. Let us first calculate this maximum amount, taking the total pressure at 760 mm., from which it will not vary by more than a few millimeters, and the temperature at 1120 deg. C., a fair average temperature for the refining process.[1]

The vapor tension of copper at 1120 deg. C. is about 0.28 mm. The partial pressure of the copper vapor in the furnace is therefore $\frac{0.28}{760} = 0.00037$. This is equivalent to saying that 0.037 per cent of the total volume of furnace gas is copper vapor. Measurements of the total volume of gas passing through the furnace and up the stack during the running of one complete charge (time about twenty hours, taken from the time when the charge begins to melt to the end of casting) showed an average of 440,000 cu. m. (15,700,000 cu. ft.) at standard conditions, 0 deg. C. and 760 mm.; 0.037 per cent of 440,000 = 163 cu. m., the volume of copper vapor passing out of the furnace. One cubic meter of copper vapor at standard conditions weighs $0.090 \times \frac{63.6}{2}$ = 2.86 kg.; 163 × 2.86 = 466 kg. (1025 lb.) of copper per charge.

Now compare this maximum possible loss with the actual loss found by experiment. The furnaces tested were 200-ton reverberatories equipped with waste-heat boilers and economizers. The dust which settles out in the waste heat apparatus and connecting flues was removed usually once a month, and the amount of copper thus recovered averaged over a period of ten months 20 kg. (44 lb.) for each charge of cathodes melted. In addition the bricks and mortar on the inside of the boiler setting become impregnated with flue dust and copper and a certain amount of slag is formed. The boiler slag was recovered from time to time and, together with the coating on the brickwork, accounted for an average of 20.5 kg. (45 lb.) of copper for each charge. The stack loss experiments showed an average of 39.1 kg. (86 lb.) of copper lost from the stack in unrecovered flue dust. Thus there is indicated a total of 79.6 kg. (175 lb.) of copper passing out of the furnace into the flue apparatus each charge.

It seems probable that nearly all of this loss is due to vaporization, since a charge of clean cathodes and remelted refined castings obviously offers little chance for other fume losses, and particles of metallic copper would for the most part be too heavy to be carried by the draft. During poling there is considerable splashing with the formation of minute particles of copper, sometimes called "copper rain," and it is probable that some of this is carried into the first boiler chamber. This question is considered further in connection with the form of the copper in the flue dust. If it is assumed for illustration that all of the 79.6 kg. is vaporized, it means that the percentage saturation of the furnace gases with copper vapor is $\frac{79.6}{466} \times 100 = 17.1$ per cent, an entirely reasonable figure.

The stack loss referred to above was determined by the usual experimental baghouse method. The temperature of filtration of the gas was about 150 deg. C. The vapor tension of copper is not known at this low temperature, but a theoretical value can be obtained by extending the vapor tension curve beyond the known limits. In this way it can be shown that the amount of copper vapor uncondensed at 150 deg. C., and therefore passing through the bags, would be a fraction of a gram.

Suppose the gases leave the furnace at 1120 deg. C. and 17 per cent saturated with copper vapor. They cool immediately to a temperature at which they are 100 per cent saturated by the amount of copper vapor pres-

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[1]For data on metallic vapor tensions and methods of calculation, see Richards' "Metallurgical Calculations," Vol. 3, pp. 588-593.

ent, and the copper accordingly begins to condense. This temperature can readily be found. At 1120 deg. 466 kg. are necessary for saturation, producing a partial pressure of $\dfrac{0.28}{760}$. The partial pressure of 79.6 kg. would be $\dfrac{79.6}{466} \times \dfrac{0.28}{760} = \dfrac{0.048}{760}$, and the vapor tension of the copper vapor would therefore be 0.048 mm. Reference to the curve shows that this tension corresponds to a saturation temperature of 1005 deg. C., or 79 deg. below the melting point of copper.

The furnace gases passed first through the waste-heat boiler, then the economizer, and then up the stack. Typical assays of the dust recovered in each of these places are as follows:

	Boiler dust.	Economizer dust.	Stack dust.
Au. Oz. per ton	0.03	0.02	0.02
Ag. Oz. per ton	3.00	2.20	1.60
Cu. per cent	28.51	18.62	15.08
S. per cent	9.41	9.00	7.91
Fe. per cent	5.55	7.21	4.47
CaO. per cent	1.26	1.27	...
Ins. per cent	28.37	25.69	...
SiO$_2$ per cent	...	...	18 33
As. per cent	...	...	0.27
Pb. per cent	...	...	0.20
Zn. per cent	...	...	Tr.

Other constituents were not determined.

Samples of the three kinds of dust were leached with boiling water. It was found that of the copper in the boiler dust about 60 per cent was soluble, in the economizer dust about 85 per cent, and in the stack dust about 90 per cent. These tests, together with the percentages
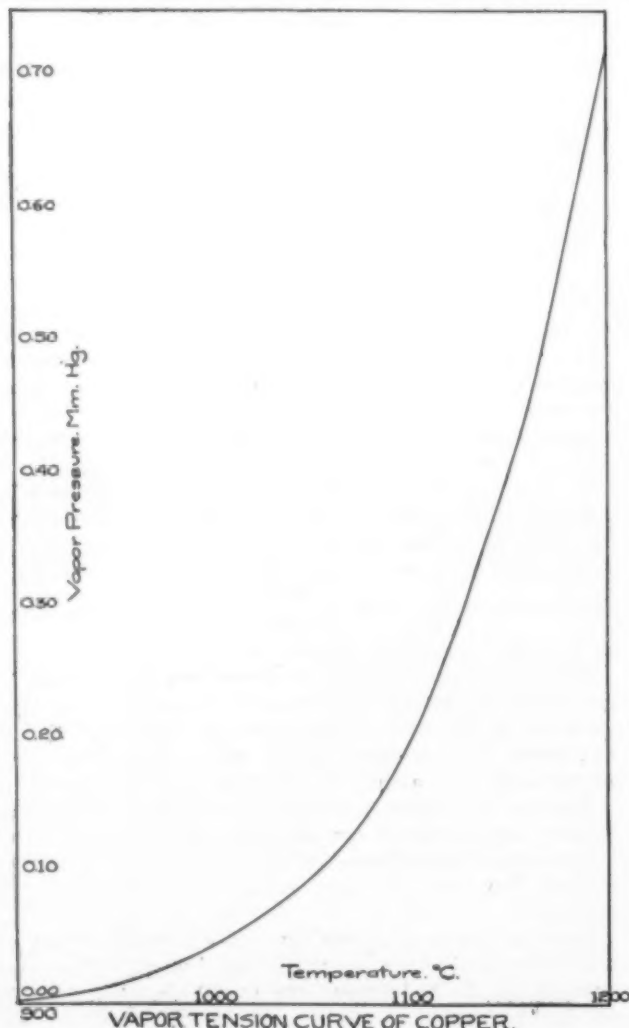
FIG. 1—VAPOR TENSION OF COPPER AS FUNCTION OF TEMPERATURE

of sulphur, made it apparent that the copper was largely present as copper sulphate. The vaporized copper must accordingly become oxidized and combine with SO_2, either before, during or after condensation. Anhydrous copper sulphate breaks up into CuO and SO_3 at 670 deg. C., so that any copper which condensed above this temperature could not combine with SO_3, at least until after condensation. The cooling below this temperature, of course, takes place very quickly in the boiler chamber. The gases enter the chamber at a temperature of about 950 deg. C., leave it at 400 deg. C., and leave the economizer at 300 deg. C. It will be noted in the above analyses that the boiler dust has the highest percentage of copper and the lowest amount soluble. This may be taken as an indication of the copper condensed above 670 deg., but it is also to be remembered that some unvaporized particles of copper may be borne into the boiler chamber, especially during poling. More information could be obtained on this point by taking samples of dust at different points in the chamber.

CONCLUSIONS

1. 440,000 cu. m. (15,700,000 cu. ft.) of gas (at standard conditions) pass through one of the 200-ton wirebar furnaces during the treatment of one charge after melting begins, and if saturated would contain 466 kg. (1025 lb.) of copper vapor.

2. 79.6 kg. (175 lb.) of copper actually passes from the furnace, probably due mostly to vaporization.

3. Of this, 39.1 kg. (86 lb.) is lost from the stack, 20.0 kg. (44 lb.) is recovered in dust from the waste-heat installation, and 20.5 kg. (45 lb.) is recovered in boiler slag and cobbing.

4. The furnace gases at 1120 deg. C. are nearly 17 per cent saturated with copper vapor.

5. The copper vapor begins to condense at 1005 deg C., which is about 55 deg. above the temperature at the entrance to the waste-heat boiler.

6. The copper is contained in the dusts largely as copper sulphate. The boiler dust averages about 28 per cent copper, the economizer dust 18 per cent, and the stack dust 15 per cent.

7. The copper in the boiler dust is about 60 per cent water soluble, in the economizer dust 85 per cent, and in the stack dust 90 per cent.

It should be borne in mind that figures on metallic vapor tensions are inexact, being for the most part drawn by inference from the known vapor tensions of mercury and supported by isolated data. Most of the figures given in this article are therefore to be regarded only as approximate. In checking the points on the vapor tension curve, the writer was able to make use of a valuable law of vapor tensions which will be published later by Dr. J. W. Richards, whereby the entire vapor tension curve of a substance may be plotted when a single point is known, e.g., the boiling point of the substance. In determining the graph for copper, the normal boiling point of the metal was taken as 2100 deg. C.

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Meeting of the Utah Section of the American Institute of Mining Engineers. On Dec. 16, 1916, the meeting of the Utah section of the institute was held at the Hotel Utah. The meeting was opened by an informal dinner. Then followed the election of officers for the coming year. After the election, J. M. Callow presented a paper, "Notes on Flotation, 1914." The second paper presented was by Erwin Wilke, entitled "The Manufacture and Use of Sulphuric Acid." A splendid musical program and entertainment helped to make the meeting of more than ordinary interest.

The Calculation of Lead Blast Furnace Charges for Students of Metallurgy

By Boyd Dudley, Jr.

Perhaps there is no better way for the student of metallurgy to become familiar with the chemical and metallurgical principles involved in a smelting process than for him to learn something of the calculation of furnace charges to be employed in conducting the operation in question. Authorities may differ on this point, but certain it is that an understanding of methods of charge calculation is an invaluable aid to the student in his critical study of any smelting process, even though it does not provide him with all of the information he should possess. Furthermore, it is the experience of the writer that charge calculation problems may be undertaken in connection with the ordinary lecture-room metallurgical course with excellent results, on account of the natural appeal that they seem to make to most students. It appears that the student recognizes, without the necessity of having it pointed out to him, that in the solution of these problems there is contained much of the essential information that he should have. Consequently, he approaches the subject with a certain degree of enthusiasm that, unfortunately, is sometimes lacking from his attitude toward other problems.

It is thought that an outline of methods for calculating lead blast furnace charges that have proven useful in class-room work will be of interest to students and teachers—perhaps to others—and it is with this idea that the present paper is presented. That there is nothing new or revolutionary in the methods to be described goes without saying. They are old and have seen long service. But they differ somewhat from those outlined in most metallurgical textbooks, and the presentation of them will therefore serve a useful purpose.

In the first place it may be well to state that a charge calculation generally consists of so determining by computation the amounts of various materials that are to be smelted that these will be present in the proportions necessary to produce, when the charge is actually smelted, a slag of the desired composition. Aside from slag composition there are other considerations to be taken into account in most charge calculations. But these are generally subsidiary to the one first mentioned, and for that reason do not have to be enumerated in detail in the definition.

METHODS OF CHARGE CALCULATION

The ordinary methods of charge calculation may be roughly divided into three classes:

1. The slag-forming constituents of each material on the charge are balanced against each other, and the excess of one constituent over the other is determined. Proper combinations of each of the various materials with the others are then made on the basis of these excesses. This is frequently called the available flux method.

2. Algebraic equations involving the amounts and analyses of the various materials and involving all of the conditions of operation are formulated and solved, the amounts of the different materials being thus determined. From the application of this method rigorously precise results may be expected. But the conditions to be observed and taken into account in the blast furnace treatment of lead ores are usually so complex that the solution of a number of simultaneous equations representing them generally proves to be a somewhat troublesome task. At least there are more speedy and equally exact ways of arriving at the desired result.

3. Preliminary estimates or guesses of the amounts of materials to be employed are made. These are entered on the charge sheet, and the weights of the different slag and matte-forming constituents are calculated from the analyses of the materials. It is then determined whether or not these constituents are present in the proportions required to produce the desired slag and to conform to the assumed conditions of operation. If they are not, a second estimate is made and the correctness or incorrectness of the amended charge is determined as before. This process is repeated until the charge is made to balance in a satisfactory manner. This is frequently known as the "cut and try" method of calculation, the name being derived from the nature of the operations employed to effect a solution of the problem.

When employed by one who has had considerable previous experience in the solution of charge calculation problems, the last mentioned method generally proves superior to the two first mentioned in point of speed, and the results can be brought to the desired degree of precision with a minimum of effort. In the hands of the student, however, this method when used alone frequently fails to demonstrate its superiority over the other two. Because the student has not had the necessary previous experience that is needed to develop the ability to judge with some degree of accuracy the amounts of the different materials to be first tried. Hence the first figures that he enters on the charge sheet may be very poorly selected. Then, too, the student is apt to be prejudiced by his previous scientific training against the use of such a method of calculation. It appears to be inexact and unscientific. The result is not secured by a method of strict mathematical analysis, therefore it ought not to be relied upon.

These and other objections arise in the mind of the student and also in the minds of many of his teachers, when the "cut and try" method of charge calculation is proposed. Some of them are just and some are not. That the result is not secured by a process of strict mathematical analysis cannot be denied, but the exactness of the result is quite another matter. The numerical values that are employed in calculations for such quantities as π and $\sqrt{2}$ are not exact, but by employing the necessary number of figures in the decimal they may be brought to such a degree of precision as may be necessary in the calculation being made. So it is with the "cut and try" charge calculation. In fact, when the vagaries of the ordinary furnace in operation are considered, the result can be brought within the necessary limits with very little trouble. As for the unscientific features of the method, they perhaps consist of nothing more serious than the production of the desired result in less time and with less mental and physical effort than it can be secured with the aid of the available flux or algebraic methods, when either of them is used alone.

But if the student is unable to employ the "cut and try" method with marked success on account of his lack of judgment, then why all this argument in favor of it? Because his judgment can be trained or developed, and this without great difficulty. The quantities of various materials that he first enters on his charge sheet need not be wild guesses. By means of available flux calculations he can make reasonably accurate estimates of the amounts of the most important of his materials, and the final adjustment of the charge can then be accomplished by cutting and trying. The amounts to be cut from or added to the preliminary estimates can also be determined according to available flux calculations. Thus he learns to make these estimates by first applying exact available flux computations to his principal materials. As experience is gained and judgment developed the available flux calculations

as a basis of preliminary estimates càn be made of a more approximate nature, and the factors judgment and experience are gradually substituted in their place. This is the method or combination of methods that the writer has found very useful in the class-room calculation of lead blast-furnace charges, and it is this that will be illustrated in the following problems.

MATERIALS SMELTED

In burdening the lead furnace the various materials employed may be classed as ores, fluxes, and fuel. There may not in all cases be a sharp line of distinction between ores and fluxes, and since the differences are largely a matter of definition they need not be discussed at length here.

Ores may be of a number of different types, and a single furnace charge may contain a large number of ores and metallurgical products having various characteristics and analyses. Frequently, however, the relative quantities of some of the ores to be smelted will be determined by the amounts or supplies of them that are available rather than by purely technical considerations. In this event, from the composition of the various ores, the relative amounts of which are so predetermined, there may be calculated at once the composition of the composite material that will result from a mixture of them. Thus in many instances even a long charge sheet may be reduced to a comparatively few items—one or two ores or composites, one or two fluxes, and fuel. It may be well to note in this connection that many smelters follow the practice of actually making these mixtures or composites previous to smelting. This is done by spreading the different lots of ore in layers one above the other, thus making ore beds; or by mixing the lots and storing in bins until the time for smelting them arrives.

The fluxes are generally a material that is rich in lime and one that is rich in iron. This is the case when silicious ores are being smelted, because the slags ordinarily produced in lead blast furnace smelting are essentially igneous solutions of silica, ferrous, oxide, and lime, with other constituents in varying but usually smaller amounts. But where ores are being smelted that are rich in lime or iron, then a material rich in silica would be an essential flux. Of the two first mentioned fluxes the former is generally limestone, which may be more or less dolomitic; while the latter may be either a natural iron ore, or in many cases it may be pyrite cinder or other roasted material containing the necessary amount of iron.

The fuel most commonly employed in modern lead smelting is coke. This may be of varying grades depending on the requirements of the individual case, or more often on the supplies available.

BEHAVIOR OF ELEMENTS DURING SMELTING

Before proceeding with the calculation of a charge for any smelting operation it is necessary to make certain assumptions with regard to the behavior of various elements in the charge during the progress of the process. Such assumptions are at best uncertain, and, in the absence of previous experience in smelting the classes of ores under consideration, it is necessary to make them as reasonable as may be and to let the matter rest with that. However, the student should bear in mind that, while he has to make a number of assumptions and solve his problems with these as a base, in a plant where a furnace is to be started many data are generally available that will show the behavior of similar charges on previous occasions. Even such data are not absolutely trustworthy, however, because differences in furnace construction that appear insignifi-

cant will sometimes produce marked differences in operating characteristics; and two furnaces working side by side under apparently the same conditions and on the same charge will frequently produce different results. So the assumptions that have to be made as a preliminary to class-room charge calculations are intended to be reasonable and to supply the student with the data needed in the solution of his problem, without necessarily corresponding to any special phase of practice.

The principal products formed by the lead blast furnace are metallic lead or base bullion; matte consisting mainly of sulphides of copper, iron, and lead; and slag, which is composed principally of silica, ferrous oxide, and lime. In addition to these there may be speise resulting from the combination of arsenic and iron, when there is much of the former element in the charge. There is always the production of some flue dust, which is carried from the furnace by the rising column of gases; and owing to the volatization of certain compounds of lead and zinc, arsenic, antimony, and other elements from the hotter portions of the furnace there is always formed a quantity of still another product called fume. The lead, matte, and slag are removed from the bottom of the furnace by tapping, while the gas, dust, and fume are drawn from the top of the furnace through the flue.

Unless the materials to be smelted are of such a nature as will give rise to excessive flue dust and volatilization losses during smelting these factors may generally be disregarded in calculating the charge. This statement does not apply, however, to sulphur and arsenic, since considerable quantities of these elements are oxidized in the furnace and escape with the gases, a point which will be more thoroughly discussed in a subsequent paragraph.

There is nearly always present in the lead furnace charge more or less copper, which for purposes of calculation may be considered as passing into the matte. Of course, some of it will enter the bullion and a little will be lost in the slag, and its concentration in the bullion will increase as its concentration in the matte increases. But for preliminary purposes, at least, the copper may be assumed to enter the matte only.

The iron, on the other hand, will pass partly into the matte and partly into the slag. Under normal conditions of operation iron is needed as sulphide as a matte constituent, and as oxide as a slag constituent.

Of other constituents of the charge that are commonly present, lime, silica, and alumina may be assumed to pass entirely into the slag; while zinc is partly volatilized, partly slagged, and in part enters the matte.

SULPHUR

One of the most uncertain factors in the operating conditions of a furnace, and at the same time a very important one, is the behavior of sulphur. A part of this element of the charge will escape from the furnace with the gases in the form of the sulphur oxides and as elemental sulphur; a part will enter the slag; and the remainder may be considered as combining with copper, iron, lead, zinc, and other metals to form the matte. The distribution of sulphur among these products depends upon many conditions, which include the chemical form in which the sulphur exists in the materials being smelted, the physical characteristics of these materials, the dimensions and lines of the furnace, the composition of the slag, and many other conditions that need not be mentioned here. It is thus evident that previous experience in smelting the materials under consideration constitutes the only reliable guide in making estimates as to the relative amounts

of sulphur that will enter the gas, matte, and slag, respectively. Even with such information at hand such estimates will sometimes be considerably in error, as has been pointed out in a preceding paragraph.

In the absence of such experience reasonable assumptions have to be made with regard to the behavior of the sulphur in the furnace. It may be assumed, for instance, that of the sulphur entering the furnace from 20 to 25 per cent will escape with the gases. The conditions within the ordinary lead furnace are of such a reducing character that no greater evolution of sulphur in the furnace gases is to be expected than this. It may be assumed that the slag produced will analyze 1 per cent sulphur, this being an average figure. After the quantities of sulphur called for by the two preceding assumptions have been deducted from that present on the charge, the remainder may be assumed to enter the matte.

MATTE COMPOSITION

The composition of the matte produced by the lead furnace is another factor of considerable uncertainty, depending as it does on the relative amounts of copper, lead, iron, zinc, sulphur, etc., that may be present in the materials charged, and also on the conditions of smelting aside from the composition of the charge. There may be very little copper and zinc in the charge, in which case the matte will consist mainly of iron and lead sulphides. It has already been noted that all of the copper of the charge may be assumed to enter the matte, and that a part of the zinc will also enter this product. A number of analyses of typical lead furnace mattes show limiting values of the most important constituents as follows:

Lead	5 to 15 per cent
Copper	1 to 15 per cent
Iron	30 to 55 per cent
Sulphur	20 to 25 per cent
Zinc	1 to 10 per cent

Of course, mattes are frequently made the constituents of which do not fall within the limits set by the above table, but the figures given will cover the general run of the lead furnace mattes ordinarily produced. It is evident that there is no particular uniformity as to matte composition, and that any assumption made without previous experience as a guide is likely to be incorrect to a greater or less degree. However, as will be seen later, the important point with reference to matte composition in so far as it affects the calculation of the charge is the ratio of iron to sulphur; and this, in the absence of excessive amounts of copper and zinc, is generally about two to one. This relation may be assumed for the ordinary conditions of lead smelting with a reasonable degree of safety. Certainly it will not lead one further astray than other assumptions of like nature.

ARSENIC AND SPEISE

Arsenic is a common constituent of ores that are smelted in the lead blast furnace, and in the main the behavior of this element is similar to that of sulphur. A part of the arsenic that enters the furnace will combine with iron forming arsenides of various compositions, depending on the conditions of smelting. The percentage of the arsenic charged that enters into such combinations is also quite variable and depends on the composition of the slag, the rate of smelting, etc. It is frequently found that the iron and arsenic have combined in proportions corresponding to the formula Fe_2As_3, containing 65.2 per cent of iron, which yields a ratio of iron to arsenic of almost two to one. In view of the manifest difficulties in the way of predetermining the behavior of arsenic in the furnace charge this relationship between iron and arsenic may as well be

assumed as any other. So that if the arsenic is present in such quantities as to impose the necessity of including it in the calculation of the charge, some such quantity as 60 to 80 per cent of the arsenic charged may be assumed to combine with iron in the ratio of two parts of iron to one of arsenic. The iron arsenide gives rise to another furnace product known as speise, which may or may not be distinguishable from the matte, depending on the relative quantities of matte and arsenide produced. Mattes will dissolve metal arsenides up to certain limits. Hence with a high matte fall and with little arsenic on the charge the speise formed may not make its appearance as such.

SLAG-FORMING CONSTITUENTS

Silica, ferrous oxide, and lime are the principal slag-forming constituents, and it is with the proper adjustment of these that the ordinary charge calculation deals. When the amounts of zinc, alumina, etc., in the materials to be smelted are comparatively low it is customary to assume that the slag to be produced will consist of a total of 90 per cent of the three principal oxides, the other 10 per cent being composed of alumina, zinc, sulphur, lead, and other elements or compounds generally present in the slag to a greater or less degree. When the amounts of these minor slag-forming constituents in the charged materials are very low, it may be well to assume that the three principals will constitute 95 or 96 per cent of the slag. On the other hand, it may in some cases be necessary to assume that the silica, ferrous oxide, and lime will constitute only 85 per cent of the slag, and that the remaining 15 per cent will be composed of the other substances. The assumption that the three principal oxides will constitute a certain percentage of the slag as produced has to be based entirely upon an estimate of the amounts of the minor slag-forming constituents present. This estimate may be, and usually is, somewhat incorrect, and in the slag as it comes from the furnace the three principal oxides are not present in the exact percentages that have been calculated. But in general the desired ratios of these oxides each to the other will be preserved, and this, in the absence of unusual conditions, will yield a satisfactory slag.

Some metallurgists in calculating their charges follow certain rules that take into account the alumina and zinc oxide and include these constituents in the slag analyses. But it would appear that for students such considerations may well be dispensed with, the first efforts, at least, being concentrated on the adjustment of silica, ferrous oxide, and lime, and the other oxides and compounds being regarded as diluents.

SLAG COMPOSITION

The proportions of the three principal slag-forming constituents to be employed in practice are determined by such a variety of technical and commercial considerations that to discuss them in detail falls outside of the scope of the present paper. It may be well, however, to note a few of the more important factors that govern the selection of a slag.

When the prevailing ore supply of the smelter is silicous in character and basic fluxes are scarce and expensive, the use of an acid or silicious slag is indicated. Of course the reverse of this proposition is also true. Likewise, the relative costs of limestone and iron flux may become determining factors in the selection of the slag. Aside from these and other commercial considerations there are a few more technical points that it may be well to mention. It is generally agreed that in smelting materials rich in zinc the lime in the slag must be kept low and the iron correspondingly high. Zinc

oxide and any considerable quantity of magnesia are also quite incompatible. Alumina may be present to the extent of about 10 per cent without complicating matters greatly, unless at the same time the amount of zinc or magnesia is high. Slags rich in iron and poor in silica apparently have a greater tendency to allow the formation of furnace accretions than do those that are higher in silica and with a greater ratio of lime to iron. These and many other factors must be considered in connection with the selection of a slag, and operating experiences bearing on the point might be cited without end. But for the work at hand, which is the calculation of the charge rather than the selection of the slag, it appears sufficient to state that the general intention in choosing a slag for a particular set of conditions is to employ the one that will yield the best commercial results. The student should bear this point well in mind—dollars and cents constitute the ultimate products of the smelter. But even in the plant it is not always possible to select in advance the slag composition that will yield the best results as measured by this standard, and far less is such a selection possible in the class room. It, therefore, again becomes necessary to employ in class-room calculations such assumptions as appear reasonable in view of the data at hand, and to let the matter rest with that.

While it is possible to vary the relative amounts of silica, ferrous oxide, and lime in the slag within comparatively wide limits, in accordance with the above outlined factors, yet it has been demonstrated by experience that there are practical limitations to such variations. The silica in successful lead furnace slags is generally not less than 28 nor more than 40 per cent. The ferrous oxide varies between 28 and 50, and lime between 10 and 30 per cent. The oxygen ratios of such slags are generally not far from unity, but slags of somewhat greater acidity than corresponds to this ratio are more common than those of less. Modern practice with large furnaces has frequently shown that what were formerly thought to be absolute limitations as to slag composition may sometimes be overstepped, the fusibility and fluidity of the slag under the conditions of its production being the ultimate guides as to its fitness. The ideas that precise ratios between lime and ferrous oxide and that a definite ratio of oxygen in the acids to oxygen in the bases had to be preserved in order to secure a good slag, if they were ever held, have now given way. Both theory and practice have contributed to this end. Laboratory studies have shown that liquid slags may be regarded as igneous solutions of their constituent oxides with the possible presence of associated compounds, rather than as fused compounds or solutions of such that might result from the combination of the oxides. At the same time commercial conditions have frequently prompted the trial of slag compositions that differed considerably from those previously employed, and where such trials met with success new possibilities as to slag composition were established.

Without discussing further the relative advantages and disadvantages of different slags, the compositions of a number of typical lead furnace slags are given in Table I. The names by which the slags are designated are derived from the exact or approximate ratios of lime to ferrous oxide, and in each case the three constituents total 90 per cent as specified in the left-hand columns of figures, and 96 per cent in the right.

Note.—The figures representing silica, ferrous oxide, and lime in the left-hand columns total 90 per cent; those in the right-hand columns total 96 per cent.

The above list of slags does not by any means include all of the compositions that have been successfully employed in lead smelting. No attempt will be made here to include all of the possibilities, nor to discuss in detail the conditions under which each slag may be properly employed. The compositions that are given, however, are representative and will serve the present purpose.

In order to demonstrate the methods of charge calculation that have been found useful in class room work several graded problems will be stated and solved. These will increase somewhat in complexity from the first to the last, and in the solution of them most of the chemical and metallurgical principles involved in blast furnace smelting for lead are brought before the student. It may be added with much truth that until the student is able to solve such problems with a certain degree of speed and accuracy he can hardly be considered as being familiar with these principles.

PROBLEM I.

Materials of compositions shown in the following table are to be charged to the lead blast furnace.

Material	SiO₂, Per Cent	Fe, Per Cent	CaO, Per Cent	S, Per Cent
Silicious ore	40.0	10.0	...	4.0
Iron ore	10.0	60.0	...	1.0
Limestone	5.0	5.0	50.0	..
Coke	5.0	1.0	1.0	1.5

Conditions and Assumptions.—It is desired to produce a slag that will contain silica 33 per cent, ferrous oxide 33 per cent, and lime 24 per cent, leaving 10 per cent to be formed by the various minor constituents not specified in the table. The amount of coke to be employed is 14 per cent of the charge. By the word charge is meant the total weight of ores and fluxes exclusive of the coke.

Assume that 20 per cent of the sulphur charged to the furnace will escape with the gases, and that the slag when produced will contain 1 per cent of sulphur. Assume that the remainder of the sulphur will enter the matte and require twice its weight of iron in forming this product.

Required.—Determine the amounts of limestone, iron ore, and coke to be smelted with 1000 lb. of the silicious ore in order to comply with the conditions and assumptions set forth above.

Notes.—It will be seen that in this first problem no account is taken of the amounts of lead and copper in the materials to be smelted. It is presumed that lead is present in the silicious ore in sufficient quantity to warrant smelting that material with the necessary fluxes. But in order to simplify matters in this first problem the lead will be omitted, and attention directed toward the proportioning of the charge in order to produce the desired slag and the assumed matte.

In the table the slag forming constituents of the coke ash are specified as percentages of the coke as a whole. Of course, these constituents are generally determined on samples of the coke ash, but in calculating the charge it is somewhat more convenient to have the analysis stated as shown.

The iron in the materials to be smelted is specified in terms of metallic iron, while the composition of the slag with respect to iron is stated in terms of ferrous

TABLE I—TYPICAL LEAD SLAGS WITH SILICA, LIME, AND FERROUS OXIDE, TOTALING 90 AND 96 PER CENT

Name	SiO₂, Per Cent		FeO, Per Cent		CaO, Per Cent	
Quarter slags	28	30	50	53	12	13
	30	32	48	50	12	13
	32	34	47	50	11	12
Half slags	30	32	40	43	20	21
	32	34	38	40	20	21
	34	36	37	40	19	20
Three-quarter slags	33	35	33	35	24	26
	37	39	30	32	23	25
Whole slag	34	36	28	30	28	29

oxide. This is on account of the fact that it is necessary to consider not only that part of the iron in the charged materials which enters the slag, but also to take into account the iron that enters the matte. It will presently be seen that for purposes of calculation it is a little more convenient to have analyses stated in terms of iron rather than ferrous oxide.

Solution.—A good starting point for such a problem as this is to calculate the ratios of the slag constituents each to the other. In this case it will be most convenient to determine the amounts of iron, lime, and sulphur that will accompany a unit weight of silica in the finished slag. Silica is chosen as the standard because an inspection of the analyses shows that silica is the predominating slag constituent in the silicious ore, and it is for the silica of this material that iron will have to be supplied by the iron ore and lime by the limestone. The slag is to consist of silica 33 per cent, ferrous oxide 33 per cent, and lime 24 per cent; there will also be present 1 per cent of sulphur. Therefore, for each unit weight of silica in the slag there will be present other constituents as follows:

$$Fe = \frac{33\% \text{ FeO} \times 56 \text{ (atomic weight of Fe)}}{33\% \text{ SiO}_2 \times 72 \text{ (molecular weight FeO)}}$$

$$= \frac{7}{9} = 0.778$$

$$CaO = \frac{24\% \text{ CaO}}{33\% \text{ SiO}_2} = 0.727$$

$$S = \frac{1\% \text{ S}}{33\% \text{ SiO}_2} = \frac{1}{33} = 0.0303$$

That is to say, for each pound of silica present in the slag as produced there must be 0.778 lb. of iron, 0.727 lb. of lime, and 0.0303 lb. of sulphur. With the aid of these factors, it will be a simple matter to determine whether or not the charge is properly balanced after the amounts of the different materials have been estimated. The factors will also be of service in making the estimates.

Next, let a charge sheet be drawn up according to the following form.

CHARGE SHEET, PROBLEM I.

Material	Weight	Silica Per Cent	Silica Wt.	Iron Per Cent	Iron Wt.	Lime Per Cent	Lime Wt.	Sulphur Per Cent	Sulphur Wt.
a—Silicious ore	1,000	40.0	400	10.0	100	...	...	4.0	40.0
b—Iron ore...	485	10.0	49	60.0	291	...	...	1.0	4.9
c—Limestone .	710	5.0	36	5.0	36	50.0	355	..	...
d—Coke, 14%..	307	5.0	15	1.0	3	1.0	3	1.5	4.6
e—Totals	...	..	500	...	430	...	358	..	49.5
f—Silicious ore	1,000		400		100		...		40.0
g—Iron ore...	500		50		300		...		5.0
h—Limestone..	725		36		36		363		
i—Coke, 14%.	312		16		3		3		4.7
j—Totals	...		502		439		366		49.7

In line *a* there is entered 1000 lb. of the silicious ore that is to be smelted. The figures representing the analysis of this material are entered in the spaces provided, and the weights of silica, iron, lime, and sulphur contained in 1000 lb. of the ore are calculated and entered in their respective spaces. In lines *b*, *c*, and *d* are entered the analyses of the iron ore, limestone, and coke, respectively. The amounts of the last three materials have not yet been estimated, so these lines of the sheet are not to be completed until the estimates are made.

In order to estimate the approximate amount of iron ore that must be smelted with 1000 lb. of the silicious ore the following procedure may be adopted. The silicious ore contains 40 lb. of sulphur. According to the assumption as to the disposal of this sulphur in the furnace, 20 per cent will escape with the gases, leaving 80 per cent to enter the matte and slag, 40 lb. × 0.80 =

32 lb. At this point it is possible to estimate only that sulphur which will enter the slag to be formed by the silica of the ore itself. Of course, there will be more silica on the charge than the 400 lb. shown in line *a*, but then too there will be more sulphur than this line shows. So, as a preliminary estimate it will be proper to divide the amount of silica in the silicious ore by 33 in order to find the amount of sulphur of that ore which will enter the slag to be produced with that silica. 400 lb. of silica ÷ 33 = 12 lb. of sulphur to the slag. Considering this ore alone, therefore, and balancing its constituents against each other, the amount of its sulphur that will enter the matte is seen to be 32 lb. — 12 lb. = 20 lb. This sulphur will require twice its weight of iron or 40 lb. The iron shown in line *a* amounts to 100 lb., of which 40 lb. will be required by the sulphur of the ore to form matte, thus leaving 100 lb. — 40 lb. = 60 lb. of iron that will enter the slag. According to the previously calculated slag ratios 0.778 lb. of iron must be present with each pound of silica. The 60 lb. of iron will therefore fulfil the iron requirement of 60 lb. ÷ 0.778 = 77 lb. of silica. The amount of silica in the silicious ore is 400 lb., and with 77 lb. of it provided with iron in the necessary ratio, there remains 400 lb. — 77 lb. = 323 lb., the iron for which must come from an external source—the iron ore.

Consider 100 lb. of the iron ore. It contains 10 lb. of silica, which will require for slag forming purposes 10 lb. × 0.778 = 8 lb., approximately, of iron. Hence of the 60 lb. of iron present 8 lb. must be allowed to accompany the silica of this material into the slag. There is also sulphur present, which will require some of the iron for matte. The amount so required, however, will be small and can be disregarded for the present. The iron requirement of the 323 lb. of silica not already provided with iron will be 323 lb. × 0.778, and if this quantity is divided by 60 lb. — 8 lb. = 52 lb. of available iron in the iron ore, and multiplied by 100, the result will be the approximate amount of iron ore required with 1000 lb. of the silicious ore. Thus,

$$\frac{323 \text{ lb.} \times 0.778 \times 100}{52} = 481 \text{ lb.}$$

At this point the natural question for the student to ask is, "Why make such a fuss about making an estimate of the amount of iron ore required, if the result, when it is obtained, is nothing but an approximation, and perhaps a rough one at that?" The answer to this question is that much more time and space are required to write out the estimate and to explain the way in which it is made than are required by the operation itself. In fact, if the reader will go over the estimate again he will see that, with the exception of solving the last expression, the entire operation can be performed mentally and without the necessity of touching pencil to paper, except to jot down occasional figures for reference; and the final relation can be solved by one setting of the slide rule. It is the intention to make all such estimates of such an approximate character that only quick mental calculations, perhaps concluded by a slide rule setting, are required.

In order to demonstrate the simplicity of the operation, the preceding work may be summarized as follows:

Consider the figures of line *a:*
Sulphur to matte and slag = 40 lb. x 0.80 = ... 32 lb.
Sulphur to slag = 400 lb. silica ÷ 33 = ... 12 lb.

Sulphur to matte = ... 20 lb.

Iron on the charge from line *a* = ...100 lb.
Iron accompanying 20 lb. sulphur to matte = 2 × 20 lb. = .. 40 lb.

Iron for slag = ... 60 lb.

Silica present in ore = ...400 lb.
Silica provided with iron = 60 lb. ÷ 0.778 = ... 77 lb.

Silica not provided with iron = ...323 lb.

. Consider the analysis of the iron ore on basis of 100 lb. of this material, line *b*:

Iron present in 100 lb. of the ore = ... 60 lb.
Iron required by 10 lb. silica = 10 lb. × 0.778 = ... 8 lb.

Iron available for slag forming, neglecting sulphur = ... 52 lb.

Amount of iron ore required to supply iron for 323 lb. of silica

$$= \frac{323 \text{ lb.} \times 0.778 \times 100}{52} = 481 \text{ lb.}$$

On account of having neglected the sulphur of the iron ore 481 lb. of this material would prove insufficient for the excess silica of 1000 lb. of the silicious ore; 485 lb. would be more nearly the required amount. Furthermore, while an examination of the analysis of the limestone shows that the silica of this material is provided with slightly more iron than the slag ratio calls for, the coke is seen to have a considerable excess of silica over iron. Hence, after the necessary amounts of limestone and coke are provided, the 485 lb. of iron ore will not furnish enough available iron for the silica thus added, it having been calculated for the silicious ore alone. On this account it might be well to make an addition to the 485 lb. of iron ore in order to bring the estimated amount nearer to the actual requirement of the entire charge, and with a little more experience that is what ought to be done. But without the experience the addition might be made as the result of a somewhat wild guess. It is better for the present to enter 485 lb. of iron ore in line *b* and see how things work out.

Having entered this amount of iron ore, and calculated and entered the amounts of silica, iron, lime, and sulphur thus added to the charge, an estimate of the amount of limestone required may be made. This operation is even simpler than the iron ore estimate, because the lime may be assumed to enter the slag completely; none of it need be deducted for the matte. The amount of silica now shown by the charge sheet is 400 lb. in line *a* and 49 lb. in line *b*, making 449 lb. According to the slag ratio, the lime requirement of 449 lb. of silica is 449 lb. × 0.727. It will be noted at this point that neither line *a* nor line *b* contain any lime, and for this reason the lime for the entire 449 lb. of silica now known to be present has to be supplied by the limestone. Considering the analysis of the limestone shown in line *c*, 100 lb. of this material is seen to contain 5 lb. of silica, which will require 5 lb. × 0.727 = 4 lb. approximately of lime. The excess of lime over silica in the limestone is therefore seen to be 50 lb. — 4 lb. = 46 lb. in each 100 lb. of the material. The amount of limestone required to supply lime for 449 lb. of silica according to the slag ratio is accordingly

$$\frac{449 \text{ lb.} \times 0.727 \times 100}{46} = 710 \text{ lb.}$$

Again it will be observed that this amount of limestone is not sufficient for the entire charge. It will provide the silica of the silicious ore, of the iron ore, and of the limestone itself with lime in the proper ratio. But it has already been pointed out that the amount of iron ore entered on the charge sheet will be low, and also it may be seen that the lime in the coke is too low to maintain with the silica of that material the proper ratio. Hence, it is to be expected that the ultimate amount of limestone will be more than 710 lb. However, this amount will be entered on the charge sheet in line *c*, and the amounts of silica, iron, and lime will be calculated and entered.

The estimate of the limestone could be reduced to a very small space as was that of the iron ore, but it will be unnecessary to do this. It should be clear that only the solution of the last expression requires anything more than mental arithmetic.

The charge is now composed of silicious ore 1000 lb., iron ore 485 lb., and limestone 710 lb. Lines *a*, *b* and *c*

of the charge sheet have been completed. Now, if the coke is to be 14 per cent of the charge, then the amount of coke will be (1000 + 485 + 710) lb. × 0.14 = 2195 lb. × 0.14 = 307 lb. This amount is entered in line *d*, and the amounts of the various constituents that it contributes are computed and entered.

The columns of figures showing the weights of the respective constituents are now added, and the totals are entered in line *e* of the charge sheet. It will be observed that in each case the weights of silica, iron, and lime have been computed only to the nearest pound, while those of sulphur have been carried to 0.1 lb. The reason for this is that the first three substances are present in relatively large amounts as compared with the sulphur, so that computations to the nearest pound in the one case and to the nearest 0.1 lb. in the other yield results of about the same degree of precision.

The charge may now be tested to determine whether or not the various constituents are present in amounts necessary to satisfy the assumptions and conditions specified in the statement of the problem. It is to be expected, as has been previously pointed out, that both the lime and the iron will be found to be present in insufficient quantities. But by balancing the charge the amounts of the deficits of these constituents can be determined, and increases in the iron ore and limestone can be made accordingly. The following outline will illustrate the method of performing this operation.

Considering the totals entered in line *e*:

Sulphur to matte and slag = 49.5 lb. × 0.80 = ... 39.6 lb.
Sulphur to slag = 500 lb. ÷ 33 = ... 15.1 lb.

Sulphur to matte after deducting gas and slag losses = .. 24.5 lb.

Iron on charge for matte and slag = ... 430 lb.
Iron to matte with sulphur = 24.5 lb × 2 = ... 49 lb.

Iron for slag = ... 381 lb.
Iron required by 50 lb. silica = 500 lb. × 0.778 = ... 389 lb.

Deficit of iron = ... 8 lb.

Lime for slag = ... 358 lb.
Lime required by 500 lb. of silica = 500 lb. × 0.727 = .. 364 lb.

Deficit of lime = ... 6 lb.

It is thus seen that the charge as shown by the first four lines of the charge sheet contains neither enough iron nor lime to produce the desired ratios of these constituents with the silica present, and to provide iron for the sulphur of the charge that will enter the matte.

In order to supply sufficient quantities of the deficient materials the amounts of iron ore and limestone must be increased. But what is the proper amount to add to each? It will be remembered that the iron ore contains approximately 52 lb. of available iron in each 100 lb. Therefore the approximate amount of iron ore to add will be found by the expression:

$$\frac{8 \text{ lb. (deficit of iron)} \times 100}{52} = 15 \text{ lb.}$$

In a similar manner the deficit of 6 lb. of lime is to be supplied by the limestone, which contains 46 per cent of lime in excess of the amount required to supply its own silica in the proper ratio. The amount of limestone to add is therefore

$$\frac{6 \text{ lb. (deficit of lime)} \times 100}{46} = 13 \text{ lb.}$$

It is well to increase this amount to 15 lb. for two reasons. In the first place it is well to keep the amounts of materials charged in terms of figures ending with 0 or 5, this for ease in computation. In the second place the addition of iron ore that is to be made will increase the amount of silica present, which is not provided with the necessary quantity of lime, by 1.5 lb. The addition of 2 lb. of limestone to the 13 lb. estimated will approximately correct this condition.

In making these changes in the charge sheet the first amounts may be erased and the new ones entered in their places. But from this procedure there generaly results a more or less begrimed sheet, and also, in the event of a third or fourth trial being necessary, it will be found more convenient to have the results of preceding trials in evidence on the sheet. Consequently, the new amounts are best entered in a new set of lines below the first, the entries being made in their respective columns, of course. In line *f* enter 1000 lb. of the silicious ore and the corresponding amounts of silica, iron, and sulphur In line *g* enter 485 lb. + increase of 15 lb. = 500 lb. of iron ore, and compute and enter the corresponding amounts of this ore's components. In line *h* enter the 710 lb. of limestone + its increase 15 lb. = 725 lb.; compute and enter the amounts of components of this material. The coke will be increased in proportion to the other increases, the new weight being (1000 + 500 + 725) lb. × 0.14 = 2225 lb. × 0.14 = 312 lb. This amount might be cut to 310 lb. for convenience in calculation, but in this case it will be entered as it is, and the weights of components of the coke calculated from the weight 312 lb. See line *i* of the sheet.

Now, in line *j* the new totals of silica, iron, lime, and sulphur are entered, and the correctness or otherwise of the revised charge is determined as before. The outline of this process follows.

Considering the totals of line *j*,

Sulphur to slag and matte = 49.7 lb. × 0.80 = ... 39.8 lb.
Sulphur to slag = 502 lb. ÷ 33 = ... 15.2 lb.

Sulphur to matte after deducting slag and gas losses = .. 14.6 lb.

Iron on charge for matte and slag = ...439 lb.
Iron to matte = 14.6 lb. sulphur to matte × 2 = ... 49 lb.

Iron for slag = ...390 lb.
Iron required by 502 lb. silica = 502 lb. × 0.778 = ...390 lb.

Lime on charge for slag = ...366 lb.
Lime required by 502 lb. silica = 502 lb. × 0.727 = ...365 lb.

Excess of lime over that required = ... 1 lb.

The balance in this case is satisfactory, that of iron being exact to the nearest pound, and that of lime being within 1 lb. The charge may therefore stand as it was last written, silicious ore 1000 lb., iron ore 500 lb., limestone 725 lb., and coke 312 lb.

The problem that has just been solved is a very simple one, purposely made so in order to illustrate the principles involved in its solution by the method adopted. Of course, the available flux calculations could have been carried throughout, and the amounts of iron ore and limestone required by each material of the charge could have been so determined. But such a procedure would have taken considerably more time and effort than did the one adopted, and the result would have differed in no way from the one obtained

It may appear that the method of solution employed was a rather "long winded" affair, and, in truth, the description of it does occupy a considerable amount of space This is due, however, not to the actual amount of work involved, but to the elaboration of details that was attempted in order to make each step in the process perfectly clear. Subsequent problems will illustrate this point, because in solving them it will be unnecessary to enter into such detailed statements.

THE MEANING OF SLAG RATIOS

Before proceeding to the next problem it may be well to deal with a point that frequently proves a stumbling block in the way of the student's understanding of the object of the game in which he is engaged. This point is best outlined by several questions that are almost invariably put when this subject is taken up in the classroom. After the silica has been supplied with iron why is it also necessary to provide lime for it? Does not the iron of the limestone require lime as well as the silica? Why does the silica in the slag have to be provided with a certain quantity of sulphur, what does it do with this sulphur? These and other questions of like nature are sure to arise, and they are apparently evolved from the idea that a definite chemical appetite of the silica for various other things is the point at issue. This appetite of the silica having been satiated with iron to the full extent of the slag ratio, should not then demand a quantity of lime by way of dessert. But it does, and how can that be? Because the so-called chemical appetite of the silica does not enter into the question at all. Simple arithmetical ratios are the factors involved in this calculation. The only chemistry that appeared was the relation between ferrous oxide and iron, and aside from this there is no chemistry whatever in such a charge calculation.

It is desired to produce a slag that will contain silica 33 per cent, ferrous oxide 33 per cent, and lime 24 per cent. At the same time it is assumed that the slag will contain 1 per cent of sulphur. Simply for convenience in calculation a unit weight of silica was selected, and the quantities of iron, lime, and sulphur that would be simultaneously present with this unit of silica in a slag of the above composition were computed. Any of the other components might have been selected as the standard, and the final result would have been precisely the same. It so happens that in the slag under consideration the components bear this relation to each other:

silica : iron : lime : sulphur = 1 : 0.778 : 0.727 : 1/33.

Now, if the iron on the charge is adjusted to the silica in the proper ratio, and if the lime is also adjusted to the silica in its proper ratio, will not the lime be adjusted to the iron in proper ratio? The answer to this question explains why, in figuring the amount of lime in excess of silica in the limestone, it was unnecessary to allow lime for the iron that was also present. Of course, that iron upon entering the slag would have to be accompanied by lime in proper quantity. But this same lime will also serve to establish proper relations with a certain quantity of silica, which in turn will require the presence of a quantity of iron determined by the slag ratio of silica to iron. Similarly, if 1/33 unit of sulphur is present in the slag for each unit of silica, and if lime and iron are present in definite quantities with reference to this unit of silica, then the proper ratios of iron and lime to the sulphur will be maintained. Will they not? In other words, the object sought in the charge calculation is the establishing of definite mutual ratios between the constituents of the slag—simply this and nothing more. Remember, the ratios are not independent, but each is related to the others in a definite manner,

(To be concluded.)

New Steel Mill in Chile.—The high cost of steel since the outbreak of the European war has started a new steel industry in Chile on a small scale. The raw material used is the old iron, formerly exported to Europe. The skilled labor consists of Spaniards, while the Chileans serve as apprentices. Chilean coal is used as fuel. It necessitated the special building of a foundry for the making of the necessary machinery. The machines to be used are of European pattern. The products of the mill are bars, plates, angles, tees, construction steel, carriage parts, nuts, bolts, nails, tires, etc. The steel produced is 20 per cent cheaper than the imported product. The mill is in operation, and, while the plant is still small, it will undoubtedly serve as the foundation for a big industry, as the Chileans are an aggressive and energetic people.

Countercurrent Decantation*

By Luther B. Eames

Mill Superintendent, Hollinger Consolidated Gold Mines, Ltd.

The recovery of dissolved gold from slime pulp in the cyanide process was first accomplished by intermittent decantation. This simple process consists in mixing with the pulp containing the values in solution, a solution of lower gold content, settling the mixture in a tank and decanting the clear supernatant fluid. The thick pulp remaining in the tank is pumped to a second tank together with more barren solution and again settled and decanted. After several repetitions of this operation, values are so far reduced that further washing is not profitable. The gold recovery of this process is high, but the plant required is bulky, labor cost is high and the amount of solution to be precipitated is excessive.

HISTORICAL DATA

As early as 1901, a plant was built in the Black Hills of South Dakota by John Randall, employing the same principles but attempting to make the process continuous by substituting for flat-bottomed tanks, cones which operated continuously, receiving a constant feed and discharging a steady stream of thickened pulp. These cones were operated in series, the thick underflow of the first one forming, with a stream of diluting solution, the feed to the second cone of the series. Barren solution was added to the tank immediately preceding the discharge tank and, after being slightly enriched by the low-grade pulp in this tank, overflowed to form a diluting solution again for the richer feed entering the third tank from the end of the series, and so on back to the richest tank of the series. Clear water was used for the wash in the final tank. This is the principle on which all successful countercurrent decantation plants operate at the present time, but Randall's plant was not successful because of mechanical difficulties in getting a continuous thick discharge from his cone tanks. A similar plant was built in South Africa, although there the washes were not repeatedly used, as in Randall's case, but were precipitated after each contact with the ore. This also was abandoned because of mechanical difficulties and the cost of precipitating the large quantities of solution that had to be used. For a number of years the process was not used, and it was not until the introduction of the Dorr thickener that the minds of metallurgists began to turn again to the continuous decantation principle.

In 1910, two decantation plants were built making use of flow sheets similar to that used by Randall 9 years before, but substituting Dorr thickeners for the cones. One of these was at Mocorito in Sinaloa, Mexico, and was installed under the direction of C. Dupre Smith, while the other was designed by J. V. N. Dorr, assisted by the writer, for the Vulture Mines Co. of Wickenburg, Ariz. While perhaps not perfect at first, both of these pioneer plants were so successful as to encourage fur-

*A paper to be presented at the New York Meeting of the American Institute of Mining Engineers in February, 1917.

ther installations, few and scattering at first but in considerable numbers during the past three years.

THEORETICAL CONSIDERATIONS

In view of this increasing importance, the following discussion of the principles and characteristics of the process is offered. For the purpose of investigation a simple yet typical flow sheet has been selected. This is shown in Fig. 1.

This flow sheet assumes that crushing is done in solution, the overflow from the tank T_s being used for the crushing solution. This crushing solution leaves the grinding circuit with the ground pulp and enters T_1, and that part which does not pass to the agitators with the pulp overflows T_1 and goes to precipitation. After depositing its gold contents, it is used to dilute the underflow of T_2 as it enters T_4. The overflow of T_2 is also mixed into the feed to T_4. The overflow of T_4 mixes with the underflow of T_2 to form the feed to T_3, and so forth, as indicated in the flow sheet. At each succeeding mixture the solution meets a pulp of higher dissolved content than itself and is enriched while the pulp is correspondingly improverished. The pulp at each step approaches the discharge end of the mill while the solution goes to the feed end—hence countercurrent decantation.

VARIABLES AFFECTING DECANTATION PROCESS

The principal variables that may affect the efficiency of the process are:

1. Grade of ore.
2. Ratio of solution precipitated to ore treated.
3. Thickness at which pulp can be discharged.
4. Cost of chemicals.
5. Rapidity of dissolving, and the place in the circuit where it takes place.
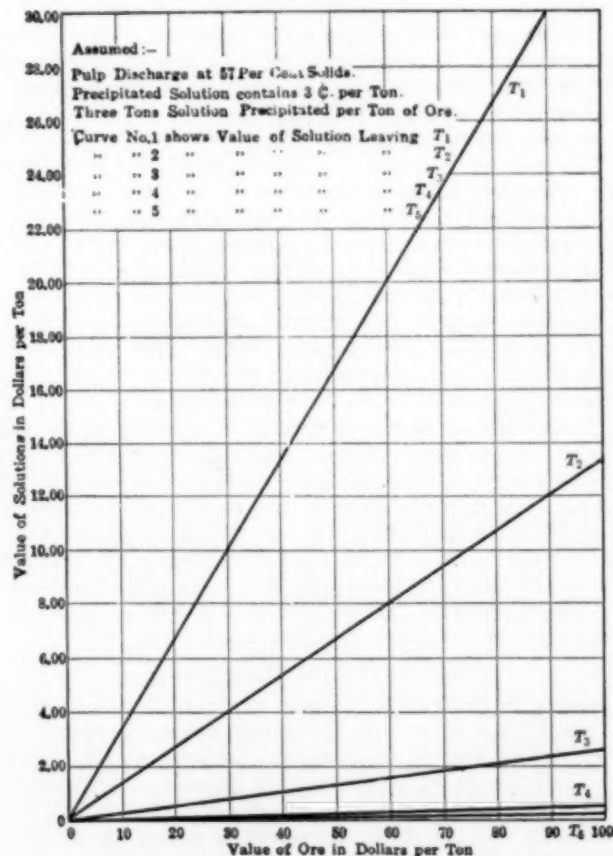6. Efficiency of precipitation.

FIG. 1—TYPICAL FLOWSHEET OF COUNTER-CURRENT SYSTEMS

FIG. 2—EFFECT OF VARIATIONS IN GRADE OF ORE TREATED

Since the decantation process is one involving volumes and dilutions, it is possible to calculate accurately what distribution of values should take place under any given set of conditions. As far as possible, each one of the above variables has been mathematically considered independently of the rest and the results have been plotted.

The effect of variations in the grade of ore is shown in Fig. 2 and scarcely needs comment. In practice, of course, no such increase as is shown in the gold-solution curve would ever be allowed to take place on account of the difficulty of precipitating such high-grade solution and the danger of leakage, but the graph shows conclusively that all solutions increase in value in direct proportion to the increase in the grade of the ore and that the higher-grade solutions increase at a much more rapid rate than the final washes.

The important part played by the ratio of solution precipitated to ore milled is shown in Fig. 3. For the particular grade of ore considered, which in this case was $10 recoverable per ton, with precipitation to 3 cents, the economic ratio may be roughly determined by inspection of the lowest curve, which represents the value of the solution leaving the last tank of the series with the tailing. It will be noted that the loss in gold increases very fast as the amount of solution precipitated is decreased, while after a certain point the increased recovery due to increasing the volume precipitated is very slight.

The final choice of the exact ratio to be used must be influenced by the cost of precipitation, which is mainly the cost of zinc. To show clearly the effect of precipitation cost on the economic precipitation ratio, Fig. 4 was plotted. I have considered it safe to assume that the cost of increasing the amount precipitated is due to the additional zinc used. The loss in dissolved gold and the cost of the zinc used in precipitation are both

FIG. 4—METHOD OF DETERMINING THE PROPER RATIO OF SOLUTION PRECIPITATED TO ORE TREATED

plotted to the same scale in cents per ton of ore. By adding the ordinates of these two curves a third is formed which represents the total loss in gold and zinc. The lowest part of this curve represents the economical range and indicates that for a $10 ore, under the conditions assumed with zinc at 26 cents, from 200 to 250 tons should be precipitated per 100 tons of ore treated. In dotted lines are shown the corresponding curves for a $5 ore under similar conditions. In this case the range is from 150 to 200 tons. While there is a considerable range within which practically identical results may be expected, it is apparent that each operator should figure out for his own conditions just what his range is.

The next, and one of the most important variables to be considered, is the thickness, or percentage of solids,

FIG. 3—EFFECT OF VARIATION IN THE RATIO OF SOLUTION PRECIPITATED TO ORE TREATED

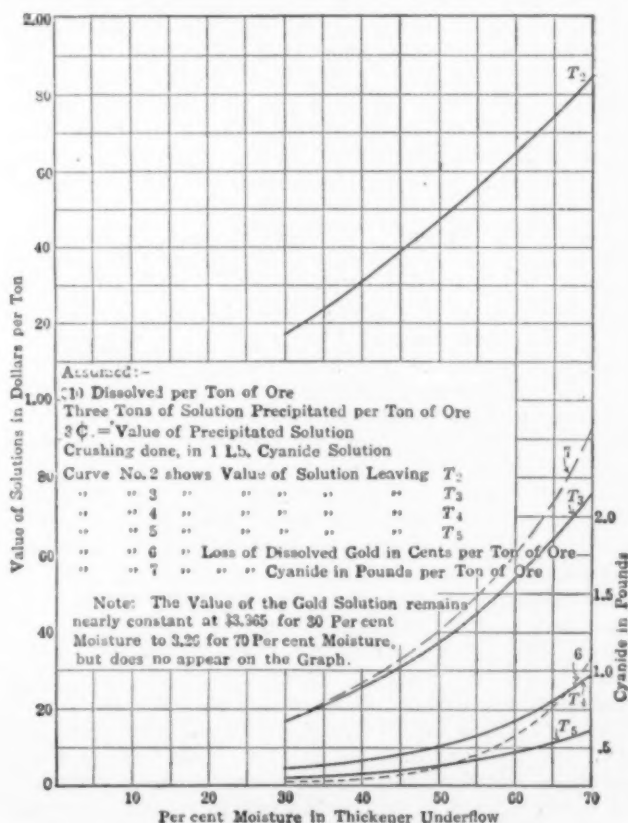FIG. 5—EFFECT OF VARIATIONS IN THE PERCENTAGE OF MOISTURE IN THE THICKENER UNDERFLOW

to which pulp can be settled. In Fig. 5 the values of the various overflows have been plotted so as to show the effect of variations in the moisture in the under-flows. The full-line curves represent the values of the solutions—that is, they are shown as per ton of solution—but in calculating losses per ton of ore, the ratio of the solution to the ore present must be considered. The loss in dissolved gold per ton of dry ore for the last tank has, therefore, been plotted in a separate curve, and it is this curve which should be given the most serious attention in determining the suitability of an ore for decantation. The moisture in the pulp also has a direct bearing on the cyanide loss, which is also shown in Fig. 5. This has been shown in pounds rather than in cents, because solution strength and the price of cyanide both affect its value. Enough is shown, however, to make it plain that there is a very decided limit to the density of the pulp that can be handled economically, and one is forcibly reminded that the cyanide strength should be kept as low as possible. Operators as a rule seem to be inclined to "play the game safe" as regards solution strength, and it is probable that in many cases cyanide could be saved without any considerable loss in gold by using solutions of a lower strength.

In making the calculations upon which the foregoing curves are based, it was assumed that 75 per cent of the gold was dissolved in the grinding department and the remaining 25 per cent in the agitators. This is, of course, an approximation which cannot be accurate, and even with the cleanest ores some gold is dissolved in passing through the tanks following the agitators. This is a condition that has always been met, no matter what the method of recovering the dissolved value. Changing solution during agitation has been practised for years in the treatment of silver ores, and in the treatment of concentrates at Goldfield with a view to reducing this lag of dissolving. I have also found that on Goldfield ore, pulp from the final agitators, reagitated without change or addition of solution, would give up no more gold, while reagitated filter tails from the same ore would show a distinct reduction. The same condition exists in the pulp fed to decantation plants, and there is little doubt that some dissolving takes place even in the last tanks of the series. Some of this value is lost, particularly that freed near the final discharge, but much is recovered that would probably not be won by any other method. The superintendent of one of the decantation plants treating Tonopah ore informed me that his sampling indicated that the additional dissolving taking place in his plant was sufficient to offset his entire dissolved loss and 3 cents per ton additional.

Any considerable dissolving during decantation will be indicated by a difference in the assay value of the solution in the underflow of the tanks as compared with the overflowing solution. In practice there is always more gold per ton in the underflow solution than in the overflow of any given tank, but in the ores of Porcupine district this difference is very small. Other causes may, and no doubt do, tend to produce this difference between the overflow and the underflowing solution. Adsorption is probably the most important and perhaps the least understood of these. In the case of the ores of the Porcupine district this phenomenon is of small importance, as the ore is composed of crystalline schists and quartz and there is little tendency for the ore to flocculate under the influence of the solutions used. The gold and silver ores of the Western States are in many cases in eruptive rocks; these ores usually flocculate in solution, and in doing so seem to entrap a portion of the value in the solution. At any rate there is a much more noticeable difference in the assays of tank

effluents in the treatment of these ores. This has in some cases been blamed on faulty mixing of the products fed to the tank. In most plants riffles and other devices are put in launders to insure thoroughness in mixing, but our experience in Porcupine would indicate that the ordinary launder makes a perfect mixture. Adsorption, then, would seem to be the more important cause of these differences, and should be a profitable field for further investigation.

Proper precipitation is essential in decantation, as it has always been in every other process, and, as shown by Fig. 6, dissolved gold is lost in proportion to the amount of value in the barren solution used. It will be observed, however, that the loss does not increase as fast as the value of the barren solution does.

It will be observed that the value of the solution leaving T_4 increases at nearly the same rate as the barren solution and that all the preceding overflows increase by exactly the same amount as T_4. The water dilution cuts the final loss down to a slower increase than the barren solution itself.

Mechanical Features

DORR THICKENER

The mechanics of the decantation system is of the simplest, but is worthy of study none the less. The Dorr thickener is universally used for the separation
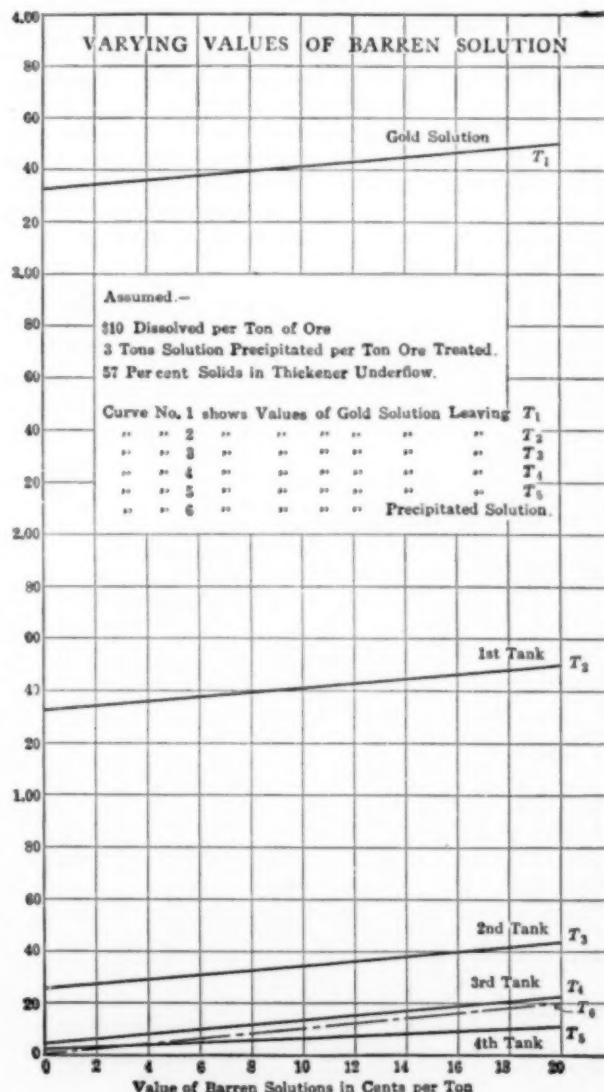

FIG. 6—EFFECT OF VARIATION IN THE VALUE OF BARREN SOLUTION

and is so well known and so standardized that it need only be mentioned in passing. It has been fully described by Mr. Dorr himself in a paper read before the Institute.[1]

The arrangement of the tanks in plan may be largely governed by space available and other local conditions. In elevation it is very convenient to have the last tank the highest and the preceding ones successively lower, so that the overflowing solutions may be transferred by gravity with a minimum of attention. Where such an arrangement is not possible, the tanks may all be placed on the same level using automatically regulated air lifts to transfer the solutions from tank to tank.

DIAPHRAGM PUMPS

As a means of transferring pulp, the diaphragm pump has distanced all competitors. The main reasons for this are that it not only pumps but at the same time measures the volume of pulp transferred. The flow of pulp is not easily obstructed by foreign matter, such as chips, waste and the like, since the openings are full pipe size straight through the pump. The capacity of the pump can be controlled with certainty by means of cone pulleys. The attendant's duties are all on one floor, as it is operated from the overflow level instead of at the bottom of the tank. Operating cost is very low on a properly designed pump.

Air lifts were used for a time, owing to their cheapness and simplicity, but they are hard to regulate and are wasteful of power. The most careful watching will not prevent them from "running away," that is, transferring too fast, consequently thinning the pulp and sending large quantities of rich underflow solution toward the discharge. On the other hand, if they are set too slow the gradual thickening of the discharge slows up the flow and finally stops it.

Spigot discharge to a bucket elevator or centrifugal-pump sump has also been tried, pulp and solution being mixed and elevated together. There are several objections to this arrangement, the principal one being high power and maintenance cost for the pumping or elevating machinery. Both the solution and the pulp must be lifted more than the full height of the tank for each decantation. The small high-velocity stream of pulp passing through a spigot at relatively high pressure is subject to frequent stoppages due to foreign matter, and even when this does not cause a complete plugging it interferes with uniformity in operation. There is also the objection that work is done on two floors, one below and one above or near the top of the tanks.

There has been a certain amount of prejudice against diaphragm pumps due to the fact that some of the earlier pumps were poorly designed for the work they had to do. Faulty valves were responsible for much of this. Poor methods of regulation also had their effect.

The practice in most plants in the Porcupine district now is to use cone pulleys for the regulation of capacity, although some of the operators favor regulation by varying the length of stroke.

The valves should be of the floating type, as any hinge device will catch the wood chips that are present in the best-screened pulp. The chips lodged in the hinge of the valve cause leaks which, though small in amount at first, cause cutting of the seat and consequently permanent leakage. With the floating valve there is no place for chips to lodge and the whole circumference of the seat is washed by pulp at every stroke. This type of valve also has the advantage that the lower valve may be placed directly below the upper one and made

[1]The Dorr Hydrometallurgical Apparatus, *Trans.*, vol. 49, pp. 211-237 (1914).

small enough to be lifted out through the upper-valve seat when the upper valve has been removed. No tools are required for the removal of these valves and it is a simple matter to inspect them.

The best results have been obtained when the working surface of both the valve and seat were of high-grade rubber. Belting was used at first, but it was found that minute leaks were almost sure to start, due to the fact that belting is not yielding enough to close over any chip that may lodge on the valve seat, and that a leak once started would ruin both valve and seat in the course of a few days. On the other hand, valves of rubber seating on rubber have operated six months without the slightest decrease in efficiency and with scarcely perceptible wear.

Diaphragm pumps have been operated at speeds varying from 15 to 100, the higher speeds usually in conjunction with a short stroke.

The practice at the Hollinger mill has been to use a low speed and a stroke as long as the diaphragm could safely stand. Measurements taken on the Hollinger pumps equipped with standard No. 4 Gould diaphragm at 3-in. stroke gave results as shown in the following table:

Number of Strokes	Volume per Stroke, Cubic Feet	Specific Gravity	Per Cent Solids
14.5	0.139	1.54	54.5
23.0	0.148	1.48	50.5

Tons Solids Pumped per Day	Per Cent Increase in Speed	Per Cent Increase in Volume per Stroke	Per Cent Increase in Tonnage
76.3			
114.5	58.5	6.5	50

From the above figures, which are typical of numbers of tests made, it may be inferred that the volume pumped is roughly proportional to the speed of the pump but that leakage is slightly greater on the lower speeds.

The low speeds and the placing of the discharge lips high enough above the discharge valve to leave 3 or 4 in. of pulp over the valve at the end of the upstroke have rendered the pumps of the Porcupine district practically free from the splash and dirt that have been one of the chief objections to diaphragm pumps in the past.

Where tanks have a settling capacity of over 125 tons of solids per day, it may be found advisable to use two diaphragms in parallel, making a duplex or even a triplex pump. This arrangement has several advantages; with the lowered speed, strains of the pump are lessened and distributed, and repairs can be made on one unit without complete stoppage of the tank discharge. Diaphragm life appears to be roughly proportioned to the number of diaphragms employed, while a corresponding decrease in the strokes per diaphragm does not result in an increased cost for diaphragms.

As a safeguard against waste and other foreign matter it is advisable to screen the pulp before it goes to the decantation tanks, and where small wood chips are to be expected a fairly fine screen, usually of punched plate, will be of great service in protecting thickeners and pumps.

MEASUREMENTS OF SOLUTION PRECIPITATED

Every cyanide plant has some method of determining the amount of solution precipitated, and in decantation plants having only one series of tanks the entire tonnage of precipitated solution is used at one place. If, however, more than one series of tanks are used it becomes important to split this precipitated solution into parts proportional to the tonnage of ore being washed in each series. This can not be done by regulating the valve at the outlet of the barren line, as trial has shown that under some conditions an increase of as much as

50 per cent can be made in the amount flowing from a pipe line without any visible change in the stream.

This difficulty has been overcome by the use of V-notch weir boxes, one for each series of tanks. In each weir box is a float compartment and a float operating an indicator on a scale which reads in tons per 24 hr. While the weir box, which can be readily made at any mine, is not a recording instrument but gives only an instantaneous rate reading, its use greatly simplifies the problem of proper distribution of barren solution. Water also should be added in proper amounts and uniformly distributed. A smaller weir box has been found convenient for this purpose.

It is usual to determine the specific gravities of various pump discharges about a decantation plant at least once a shift. In a small plant this consumes little time but if there is a large number of measurements to be made the distance to be covered by the operator is considerable, especially if he has to return to a central point for each weighing. In such plants, a spring balance with a dial and revolving hand, that can be carried about the plant, is a good type. I have used a milk scale having an adjustable tare-indicating hand, which makes one complete revolution for 10 lb. I use a narrow-necked can which holds just 10 lb. of water when level full. This makes it possible to add a paper dial which can easily be divided so as to read directly specific gravities. The large sample makes possible accurate readings and enables the operator to determine gravity at the place where the sample is taken.

TRAY THICKENERS

In his paper on the Dorr metallurgical apparatus, Mr. Dorr touched on the future of tray thickeners, and spoke of the possiblity of a complete decantation plant being installed in one tank. While this has not been done as yet, a four-step decantation followed by a continuous filter is in operation, the four steps of the decantation being completed in two tanks equipped with single trays. While no figures have been made public the results are said to be creditable.

Another use of the tray in decantation, which is shortly to be tried at the Hollinger mill, is to increase the capacity of existing plant rather than to decrease the number of tanks installed. Since the same grade of solution is handled in both tank and tray there is no danger of any mixing of solutions of different grades. This plan should decrease the cost of buildings, tank foundations and building site in almost direct proportion to the increase in capacity gained, while tank cost, power and labor should all be decreased to a marked degree. The outcome of this experiment should have a direct bearing on the future of the decantation process. It must, however, be borne in mind in this connection that some slimes require time for their final thickening and consequently necessitate a tank of some depth, while other slimes find their capacity limit in the thin-pulp settling rate. For this latter class, as explained by Messrs. Coe and Clevenger in their paper on slime settling,[2] a shallow tank or tray is sufficient while the former class requires a tank of carefully calculated depth to give the required time for thickening.

The Decantation Plant of the Hollinger Co.

The Hollinger decantation plant consists at present of five rows of 40-ft. tanks, four tanks to a row, forming a plant of five units. The tanks are arranged with a difference in elevation of 2 ft. 6 in. between steps with the final tanks of the series the highest, so that all solutions gravitate through and out of the plant to precipi-

[2] Laboratory Method for Determining the Capacities of Slime-Settling Tanks, *Bulletin* No. 111, p. 597 (March, 1916).

tation. The Barrett specification roof is supported on flat trusses, the lower cords of which pass just above the tank rims. These trusses also serve to support the thickener mechanisms as well as the walks between the tanks.

The diaphragm pumps used were designed by the company's staff, and have been very reliable and economical. They are all three-throw or triplex pumps so that in spite of the large tonnage handled the duty on each diaphragm is light. It is not uncommon for diaphragms to last 300 days while the life of the present type of valves and seats has yet to be determined.

The pumps are used not only for pulp transferral, but also for the final discharge. This makes regulation of the final discharge for moisture much easier, more reliable, keeps the work of the operator all on the upper floor and allows the tailing to be discharged at a considerably greater elevation than would otherwise be the case.

The barren solution and water wash added to each row are measured by separate float-reading weir boxes assuring uniform results from the various units.

LABOR

The plant is operated by one man per shift who oils all machinery, watches and adjusts the pumps and records their performance. The solution man makes titrations and regulates the addition of water solution but has no other duties in the decantation plant. A repair man on day shift makes all repairs and has time for other work.

POWER

The power for each tank including motor and line-shaft losses is under 1 hp., while each three-throw pump consumes about the same amount.

COST

The costs for the twelve weeks from Jan. 28, to April 21, 1916, have been taken as typical of what is done by this plant at its present capacity. During this time 85,-854 tons were decanted at a cost of $599 for supplies, including power, and $1,194 for labor, or $0.007 per ton for power and supplies, and $0.0139 for labor, making a total of $0.0209 per ton for decantation. Labor is no doubt higher here than it will be in the future, as a greatly increased tonnage is to be treated while supplies and power should remain nearly the same. The cost as it stands is about 40 per cent of the cost of filtering on leaf filters at about the same daily tonnage.

EXTRACTION AND RECOVERY

In the ores of the Porcupine district the recovery by dilution seems to be almost the theoretical maximum. Adsorption does not seem to have any appreciable effect. There is a slight dissolving during decantation which, while it adds to the recovery, makes the soluble loss somewhat greater than it would otherwise be.

The figures quoted below on chemical consumption and recovery refer to only two units of the Hollinger plant. The figures on these units are given because the other units of the mill share their feed with the original Moore filter plant, and likewise their barren solution, while for commercial reasons the two units in question have been given a separate solution system and separate precipitation presses. These two units are therefore the only ones upon which all the figures are available.

In comparing the results quoted, however, it should be borne in mind that the flow sheet has been modified in this plant somewhat because of limitations of space, so that the overflow of T_2 instead of that of T_1 goes to precipitation. The effect of this is to raise the theo-

retical value of the overflow of the last tank 3 cents at 3 to 1 precipitation.

A statement of results follows:

Period covered, same as that for which costs were given—from Jan. 28, 1916, to April 21, 1916.

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Tons of ore treated ..........................................38,885
Value per ton ore treated....................................$8.92
Ratio of ore to solution precipitated....................100 to 285
Tons solution precipitated....................................110,604
Strength of cyanide used..........0.9 lb. per ton, or 0.0045 per cent
Cyanide added per ton of ore..................................0.46 lb.
Difference between pulp feed and pulp discharge for first tank
   after agitators ...........................................25 c.
Averge moisture in tails ..............................45 per cent
Average value of barren solution.............................3.2 c.
Dissolved gold per ton of solution discharged.............11.71 c.
Dissolved gold per ton of ore discharged..................9.57 c.
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It is theoretically possible, taking into consideration the flow sheet, the grade of ore treated, the barren solution used and the thickness of pulp attained, to have reduced the overflow of the last tank to 7.6 cents, leaving a difference of 4.1 cents to be accounted for by continued dissolving adsorption, etc.

Viewed in one way it may be said that actual losses are 54 per cent higher than theoretical, but where one is dealing with samples so easily affected by faulty manipulation and where any error except losses in assaying tends to raise the results, a check to 4 cents does not seem bad. The average loss would have been somewhat less if the occasional high results had been omitted, but this was not done.

From the foregoing, I believe one is warranted in concluding that a reasonably accurate forecast can be made of the results to be expected from a decantation plant and that these results may compare very favorably with the results obtained from filter plants.

In conclusion I would say that I am indebted to P. A. Robbins, managing director of The Hollinger Company, for permission to quote results from the Hollinger plant.

Timmins, Ont., Canada.

The Rubber Situation

By Andrew H. King

In a previous paper I outlined the rubber situation as far as this country is concerned. I endeavored to show that we as a people are almost absolutely dependent upon Great Britain for our supply of crude rubber, the utilization of which material goes hand in hand with civilization. If you wish to see what a rubberless community would be like, look on Germany. Her supply is so low that rubber is only used in cases of absolute necessity. Consider her wooden tired motor trucks, and her celluloid nursing nipples. What did the merchant submarine Deutschland take back with her? Gold? No, mostly rubber. It is exactly such a situation that we as a people must guard against.

The proposition is full of pitfalls, even in peace times. The British will certainly be human enough to make us stand their bills for the great war if they can find a means to do so. It has already been suggested by certain unofficial sources that there should be an export duty on rubber. Straws show which way the wind blows, and while nothing really definite has been done, it is evident that they are looking for a way out.

It will be remembered that a few years ago, when Germany first began to put the screws on the potash exportation, that certain enterprising Americans bought in on the ground floor. The matter is now history, but the fact remains that they got out with a brand new lesson in their hats, namely the wisdom of staying away from a foreign monopoly. Several of our rubber companies may have to learn the same lesson, for it is well known that certain plantations in Sumatra and in the Federated Malay States are controlled, if not owned outright, by American capital. Considerable weight is given the old saying that blood is thicker than water. These capitalists place great faith in Englishmen, and while I do not wish to injure that faith, I cannot refrain from pointing out the confiscation of German patents by Great Britain. If she will confiscate intellectual property, what may she do to real property in the event of a slight misunderstanding between our respective countries?

There is quite a similarity between the potash and rubber situations. If given time enough it now appears that we will solve the former. The importance of American control has been effectually demonstrated. We must not allow the German monopoly to crush out this infant industry, for should this calamity occur the foundation of our national existence would be weakened, and ultimately a condition might arise when we would learn again that a chain is no stronger than its weakest link.

Fortunately, the rubber problem is not nearly as serious, nor nearly as difficult of attack as that of potash. We have plenty of methods of approach, plenty of skilled minds to call upon, and only lack the necessary capital and incentive. Only a few years ago we saw such an epidemic of wildcat speculation in rubber, and particularly in synthetic rubber, that the general public has been rendered a little leery of rubber investments. However, better times have dawned, and our bankers have learned that there are certain reliable persons called experts who will advise them well. Consequently we have reason to hope for action.

Let us grant for sake of argument that we need an American rubber industry. Let us also grant that we have the necessary capital to go into the matter. How shall we go about it? What avenues lay before us? Shall we pin our hopes to the Guayule shrub, or to any other cousin shrubs which happen to bear rubber? Shall we establish plantations in the Philippine Islands, or in Hawaii? Or shall we resort to the chemist and plunge on synthetic rubber?

In a previous paper I discussed Guayule. The possibility of its revival is very certain. Ever since 1912 considerable shrub-bearing areas have been idle—practically untouched. When the Mexican trouble is over this will mean a large Guayule harvest. At such time a program of conservation must be adopted or the plant will become extinct.

There are other plants acclimated to temperate zone conditions that are worthy of passing mention.

Our common milkweed, *Asclepias Syriaca*, is a rubber producer. It grows abundantly throughout the United States, and is probably better known than any other weed. Its latex, as reported by Fox (*India Rubber World*, 1914, page 645), is thin, milklike, and possesses an acid or neutral reaction, besides the characteristic milkweed odor. It may be coagulated by heat or by alcohol. The coagulum is plastic, and when molded into cakes resembles low-grade rubber. The rubber present is of inferior quality, and on the basis of latex represents a yield of only 2 to 3 per cent. The resin contains asclepiadin, which drug finds application in dropsy, etc. The rubber might be improved by Spence's sodium process, but the production of anything like commercial quantities would involve so much asclepiadin as to make this otherwise moderately valuable by-product a liability rather than an asset. A point which has been overlooked heretofore is the fact that this weed produces at seedtime a very beautiful, pure white and glossy fiber, which if properly prepared produces a fabric greatly resembling silk. If the production of this fiber were made the principal industry, it might be that the extraction of the rubber from the stalks would furnish a profitable by-product.

FIG. 1—ASCLEPIAS SYRIACA. FLOWERING PLANT OF
COMMON MILKWEED

(Photograph by Miss E. M. Kittredge, Spring Valley, N. Y.)

FIG. 2—ASCLEPIAS SYRIACA. FRUITING PLANT OF
COMMON MILKWEED

(Photograph by Miss E. M. Kittredge, Spring Valley, N. Y.)

The great *Apocyanaceae* family yields a varied series of products, among which are the *Landolphia*, and *Funtumia* rubbers of Africa. It would be expected that the American representative of the family should also be rubber producing. The latex of the well known Indian Hemp or Canadian Hemp (*Apocynum Cannabinum*) contains (Fox, same reference as above) 2.36 per cent rubber—on the weight of latex. This latex is preferably coagulated by acetone, and yields a strong black rubber of very fair quality. The root of this plant yields apocynum, which drug is used in medicine. The bark is strong, fibrous and tough, and was formerly highly valued by the Indians for bow strings. Unless very profitable by-products can be developed from these two plants their value as rubber producers is practically nil.

The Pingue plant, *Actinella Richardsonii* (Fox, *India Rubber World*, 1913, page 467), is related to Guayule, and is found in New Mexico and southern Colorado. It differs from Guayule in that the roots contain the rubber and the tops furnish slips for planting. This plant grows in a deep, sandy soil and the root contains about 7 per cent of a good grade of rubber.

There are many other plants which bear a small quantity of rubber, but to date only Guayule and Pingue have proved profitable

Chicle contains about 17 per cent of rubber, and has been proposed from time to time as a possible source. This gum belongs to the rubber family, and is secured from the latex of *Achras sapota*. The trees grow in Central and South America, and the latex is secured by very crude methods, which in the advent of a great demand would be liable to permanently destroy the supply. However, scientific methods of tapping could be introduced, and the gum harvested in an economical manner.

But the unfortunate part of this idea is that chicle is already the basis of a very profitable industry, namely, chewing gum, the average retail value of which is about $30,000,000 per year, in this country alone. The customary 5-cent package weighs about 1 ounce, and contains about ¼ ounce of chicle. By a little calculation it is evident that about 600,000,000 packages are sold annually, which represent, say, 10,000,000 lb. of chicle, valued at 60 to 65 cents per pound. On the basis of 25 per cent, this means an annual consumption of about 40,000,000 lb. of chewing gum, the retail value of which is about 75 cents per pound. Since the other ingredients are relatively cheap, the profit on chicle importation must be enormous. In view of the above, any process for the production of rubber using chicle as a base seems to me to be analogous to the substitution of gold for steel in rails. Another point on the subject is that should such a proposition be feasible, we would still be dependent upon a foreign country and upon water transportation, neither of which is considered desirable from a preparedness standpoint.

However, in case of absolute necessity the public can be relied upon to follow up a gigantic salvage campaign, which could furnish us with 1,700,000 lb. of rubber at the bare cost of extraction. Might not this be a good idea for the rubber chemist to investigate even in peace time?

Let us now consider the advisability of establishing plantations in the Philippine Islands. From the very start we must realize that such a procedure would only give us peace time relief, for in the event of war our navy could not be expected to keep the lanes of the sea absolutely free from hostile vessels. At the very best our losses would be considerable. That this is true we have only to consider England's navy, the grandest and mightiest in the world, yet it cannot rid the ocean of

the dreaded "Unterseebote." An absolute blockade of our ports is rather remote. Unless America should face a coalition of enemies we have nothing to fear. Only Great Britain could make us really uncomfortable. I am thinking now of the time when our great naval and military program will be well under way. At the present writing—but why be pessimistic?

I have reliable information that the greatest drawback which has heretofore prevented capital from planting in the Philippines is the extreme uncertainty of the situation. It has been the obsession of one of our political parties to set these islands adrift—at such time as they seem fit to rule themselves.

Now, is this the right attitude? Let us think of the Philippine Islands one hundred years from now, or the thousand years some people say will be needed before this desideratum is reached. Let us consider that at this time the Filipinos will be capable of self-government. Will they as a people require any more freedom than the people of New Jersey or of Kansas? The desire for freedom and liberty is a natural one, but are the people of these states any less free because of their allegiance to the United States of America? As the Filipinos progress in the study of civil government, will they not appreciate the virtues of a union with the United States?

By all the laws of right and justice the Philippines belong to America. We delivered them from the curse of a decaying empire, saved them from oppression, and paid in gold for their acquisition.

Has the American rule been tyrannical? Have we despoiled their people? Not at all. We have kept order, when necessary, by force of arms. That was our duty, the same as it is the duty of every city police force. We could not permit a state of anarchy to exist such as now exists in Mexico. We abolished an antiquated land system, not by force of arms or by imperial decree, but by some millions of American money paid for friar lands. We sent good American teachers and set up a school system, the working of which has been little short of marvelous. In every way American occupation has been a good thing for the islands. We certainly deserve some gratitude from the Filipinos. We have given them our blood, our money, our brains, and our time. Why should they not appreciate these things, and be content to remain under our flag? The mutual benefits would be very great.

With the Philippines definitely decided as part of the United States, American plantations there would be very good business. On the other hand, should the

islands be set free there is a possibility of an outbreak of anarchy. Anarchy and business never go together.

It would be well for us now to pay attention to the work of the British planters in the Far East. They have used great skill, patience and foresight. They had to contend with the most adverse conditions, but with characteristic British energy they have created an industry, the magnitude and earning power of which we little appreciate. The establishment of plantation rubber is one of their masterpieces.

In 1877 H. A. Wickham smuggled some 70,000 seeds of *Hevea Brasiliensis* out of Brazil. They were planted in London, and the slips sent on to Ceylon. This was the beginning of an industry that supplied in 1915 about 100,000 tons of crude rubber—68½ per cent of the world's supply.

The major part of the planting has been done in the Federated Malay States, and in Sumatra. To date the capital outlay has been enormous, amounting to about $320,000,000. In the early days interplanting was resorted to to help carry the load. Tea and coffee found the greatest favor. As the Hevea trees came into bearing these quick crops were gradually discontinued.
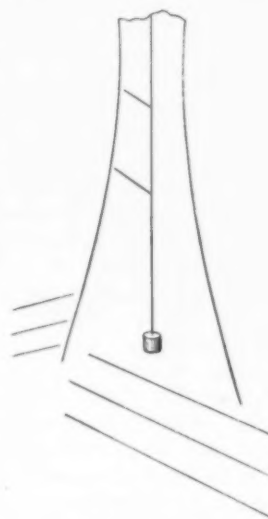
The present custom as to planting is as follows: The jungle is cut down and the ground thoroughly drained and cleaned of all old roots, which if left to decay would be liable to cause root disease in the young trees. The seedlings, which have been carefully raised in nurseries under the direction of competent foresters, are set out about 120 to 150 to the acre. As the trees grow they are gradually thinned out until only about 50 to 80 per cent are remaining. This number depends considerably upon the depth of the soil. As would be expected only the poor trees are removed. It is entirely a matter of survival of the fittest. From the time the tree is set out until tapping, which is ordinarily begun in the third or fourth year, about all that is necessary is to keep the plantation weeded, and to turn over the soil around the base of the tree about once a year. It is customary to fertilize with lime and manure, and on poor soils to use a little sulphate of ammonia. Pruning is resorted to when necessary, and all cuts are covered with some preparation to protect the tree from insects.

The tapping problem has received considerable attention. It is quite obvious that maximum ultimate yield per acre is much to be preferred to maximum yield per tree per year. The parts of the tree are: The pitch, wood, cambium, the cortex and the bark. It is necessary to cut through the bark and almost through the cortex, which contains the latex cells. The cambium is a very sensitive membrane, and must not be injured in any way or a wart will form which may kill the tree. The cortex is only about 12 mm. thick, consequently the cuts are of an average depth of only 10 mm. in the cortex.

The half herringbone system of tapping has proved most satisfactory. It was formerly the idea that the more cuts in a tree the greater the yield per tree per year. Unfortunately this did not give the greatest total

SKETCH SHOWING HALF-HERRING BONE SYSTEM

Map showing Far East
Shaded portions indicate present rubber producing areas.
Heavy black portions show regions for possible planting in the Philippines

yield per acre in the long run. By a long series of experiments the present half herringbone quartering system has been evolved. When first tapped, the tree is laid off into quarters, and in only one quarter are two narrow cuts made, these leading to a central channel. The latex flows down these cuts into the central channel, and down this to an earthenware cup. The tree is tapped nearly every day by removing a very thin shaving of bark and cortex. After a month's time the cuts will have widened only about an inch. By the end of the year they will be together. The next year the operation is repeated on the opposite quarter; the third year cut is made on an adjacent quarter, and that
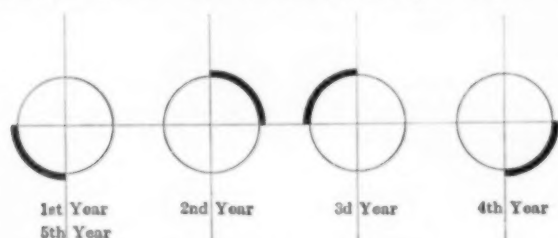
SKETCH SHOWING QUARTERING SYSTEM

of the fourth on the opposite one to this. By the fifth year, which is the eighth or ninth of the life of the tree, the bark covers the first section and tapping is resumed on the same quarter that was first used. Tapping is really a fine art, and the Malay has proved quite efficient and satisfactory at it.

The latex is carried to the coagulating stations, strained to remove all sticks and other dirt, as well as such lumps of naturally coagulated material as may be present. It is then poured into shallow pans and coagulated by means of acid. Acetic acid finds the greatest use owing to the wide range in permissible concentration to completely precipitate all the rubber. With sulphuric acid this range is only 0.1 to 0.2 per cent, while with acetic the concentration may vary from 0.09 to 0.8 per cent, thus making its use very nearly foolproof. Other acids can be used such as tartaric, oxalic, formic, etc. Chinese vinegar also sometimes finds application.

After allowing the coagulum to settle, usually over night, the surface scum is removed, the rubber taken out and worked into slabs, which are left with considerable latex inclosed for about six days. This procedure is to give the proteins in the rubber and in the latex an opportunity to decompose into certain undefined substances which give a rapid curing rubber. The work of Eaton and Grantham (the Agricultural Bulletin, Federated Malay States, vol. 3 and 4, various numbers) on the subject of "Variability" has thrown a very great light on the subject of coagulation and the properties of rubber secured under different conditions.

Plantations are at present producing only three important grades, namely: Pale Crepe, Smoked Sheets and Brown Crepe. Pale Crepe is the very finest of their product, and on the largest plantations now amounts to from 70 to 80 per cent of the total output. In some districts it is the custom to add a little sodium sulfite to the latex before coagulating, but this is no longer an absolute necessity, since with care and cleanliness a very satisfactory rubber can be secured without it.

After the slabs have been stored six days they are milled, washed, and hung in a loft to dry for two to three months, following which the thin sheets are ready for packing.

If smoked sheets are to be prepared the rubber is put through the same process as above and the sheets hung in a smokehouse where a slow fire of cocoanut husks is kept burning. After ten to fifteen days the sheets are removed and the soot brushed off, when they are ready for packing.

Brown Crepe consists of surface skimmings, natural coagulated lumps, and the better grades of scrap. Some plantations make only Brown Crepe, but these are not many. There are also numerous grades of "scrap," which make up but a very small part of the total output.

The yield from one tree is not large, varying from three to seven pounds, depending upon the age of the tree. Arden (India Rubber Journal, 1916, page 199), states that trees properly cared for will yield about 7 lb. per year when 10 to 12 years old, which, on the basis of 60 trees per acre, amounts to 420 lb. per acre per year. He also estimates the "all in" costs on trees yielding the above amount. He places it at 9.5d., or about 19½c. per lb. He remarks also that with rubber selling at a shilling a pound (i. e., about 24½c.) a profit of 2½d. per lb. would be realized, or £4 7s. 6d. ($21.29) per acre, which would be sufficient to pay a dividend of 10 per cent on an acre capitalized at £43 15s. ($212.91). Mr. Arden does not fear any speedy drop in the price of crude rubber, but simply gives these figures to show the soundness of the business.

It must not be taken that the trees yield anything near like 420 lb. per acre when first tapped. Taking the average number of trees per acre from the time of planting to the 10th or 12th year as 100, the schedule is approximately as follows:

1st year of tapping	70 lb. per acre
2nd year of tapping	140 lb. per acre
3rd year of tapping	*250 lb. per acre
4th year of tapping	325 lb. per acre
5th year of tapping	375 lb. per acre
6th year of tapping	400 lb. per acre

*This is the maximum yield in some parts of Ceylon.

In spite of war conditions the world's consumption of rubber has increased by 20 to 30 per cent. It is estimated that the Far East has produced in 1916 about 140,000 tons, an increase of 40,000 tons or 40 per cent over the 1915 yield. There is absolutely no such thing as flooding the rubber market. As the quality available increases, the applications multiply and no one can see the end.

To go back to the Philippines, *Hevea Brasiliensis* has been found to grow most satisfactorily in a belt 10 deg. on either side of the equator. This belt includes the Philippine province of Moro, whose most northern point is about 9 deg. north latitude. This district includes the island of Mindanao, its tributary island Basilan, and other smaller islands. It is a truly tropical region, and very well adapted to planting. The soil is equal in every way to that of the best rubber-growing district in the world. The rainfall is about 100 in. annually, and is evenly distributed. The temperature rarely exceeds 92 deg. Fahr., and what is more important the province lies outside of the typhoon belt. This is a distinct advantage, since storms often wreak great havoc in Ceylon, Sumatra, and others of the British possessions in the Far East.

There have been small experimental plantations started in this district. About 6000 acres are now under cultivation. The planting averages about 90 per cent Hevea, and 10 per cent Castilloa. Some Ceara has also been planted, but it was found to be unsatisfactory.

The Agricultural Department of the Moro province has published the following figures, which show the relative costs of bringing new land under cultivation in the island of Mindanao, and in various other islands of the Far East.

Moro	$50.94 per acre
Sumatra	73.60 per acre
Java	109.94 per acre
Federated Malay States	137.42 per acre

The relative costs of upkeep are given as follows:

Moro	$18.00 per acre
Sumatra	20.00 per acre
Java	23.00 per acre
Federated Malay States	29.00 per acre

Taking all in all, it is estimated that an acre of land may be prepared, planted, and brought to bearing in the fifth year for $150.

The labor situation is good, the average Malay is quite intelligent, and shows evidence of a one-time civilization of no mean sort. The stories of the ancient Malay empire may not be as mythical as is commonly supposed, but laying all that aside he can be trained to perform the most skillful operations, and the tapping of rubber trees is but one of these. He is reasonably industrious, and if properly handled proves quite satisfactory. The daily wage prevailing ranges from 20 to 30 cents. If anything be needed to make the proposition more lucrative, it is found in the large tracts of government land which can be secured quite reasonably.

Besides the island of Mindanao, the island of Mindoro has also been the scene of considerable experimental planting, with a fair degree of success notwithstanding the fact that it lays at about 13 deg. North latitude. Experiments in the Philippines have languished for want of capital. There are great possibilities there, and what is most needed is for the American people to get behind the proposition and push.

Some experiments have also been made in the Hawaiian Islands. Up to 1913, the date last reported, about 1500 acres were planted in rubber. Of this area about 300 acres are planted in Hevea, and 1200 in Ceara. (*Manihot Glaziowii.*) The latter has been found to be most satisfactory in this region, notwithstanding the fact that the tree drops its leaves annually and must therefore be left alone from February to May.

The soil is porous, the rainfall about 100 to 200 in. per year. The planting has been done in the Nakiku district of the island of Maui, and in the Puria district of the island of Hawaii. A fair degree of rubber has been produced, but considering everything it is the writer's opinion that the place for American plantations is the Philippines rather than Hawaii.

It has been my aim to present the possibilities of an American crude rubber business. To my mind we must resort to Guayule if we would produce rubber in any quantity within our borders. This step is absolutely necessary as a preparedness measure. Moreover, there is money in it. Experiments along this line are now almost completed, and in the very near future we can expect cultivated Guayule to take its place among commercial rubbers.

A plantation industry in the Philippines would be entirely a good business proposition, if certain parties would quit playing schoolboy politics and recognize the economic needs of the nation.

At this time there is strong talk in England and in France of replacing the embargo on crude rubber exports. The claim has been made that the Rubber Club of America has failed to live up to its agreement in allowing the submarine Deutschland to obtain two cargoes of rubber from this country. This agreement has to do only with rubber obtained from British and French possessions, and the Deutschland's first cargo is reported to have been obtained by certain parties in the open market. Very probably some British rubber made up that cargo, but by that act those parties are forever barred from further purchases, and have brought upon themselves the ostracism of every American rubber man. The second cargo was obtained from the Dutch East Indies, and the British Government has nothing whatever

to say in the matter. The Rubber Club of America has lived up to its agreement to the very best of its ability, but having no police power it cannot prevent occasional infractions of the rules. It can and does say that such parties as break the rules once can never do so again.

The possibility of the restoration of the embargo makes me as an American wish to go them one better, and grow our own rubber.

The subject of synthetic rubber will be taken up in a subsequent paper.

Training the Works Chemist
By Frank E. Lathe,

Chief Chemist, Granby Cons. Mining, Smelting & Power Co., Ltd.

I well remember my surprise, when, on securing a position as chemist shortly after graduating, I learned that I would be expected to do each morning in about two hours, work that would have taken me more nearly two weeks in the college laboratory. Probably many another college man has had a similar experience, even leading him to question the practical value of his training. However, I think, it will be generally conceded that the chief value of technical training lies, not in the precise methods taught, but rather in the fundamental principles of chemistry on which all methods must be based, and on a general familiarity with the various operations to be performed. But the fact that theory is more important to the college man than practice is a poor reason for not teaching the student to make the most of his laboratory periods, and a little applied common sense—scientific management, for those who prefer the phrase—will not only fit him better for the practice which will eventually become his daily work, but will also enable him to accomplish far more in the limited hours to be devoted to practical work at college.

Many teachers of analytical chemistry have had no experience in work of this kind under commercial conditions. They may owe their appointment to their ability to make very accurate analyses, or to the fact that they were capable research chemists. If so they are scarcely to be blamed for worshipping the god of accuracy and shunning the demon of speed—but how often the furnaceman requires to know in a few minutes the approximate sulphur content of his steel, or the grade of his copper matte, while accurate results given him the next day would be worthless! In practical work accuracy must frequently be sacrificed to speed, and while some of the quick methods are already taught in our colleges I want to enter a plea for more instructors who have made good under actual working conditions, and who will therefore direct the energies of their students along the most practical lines. In the case of mining and metallurgical students this may often be accomplished by placing all quantitative analysis under the complete control of the metallurgical department.

I will now indicate some of the points which I believe might well receive greater emphasis in the training of the chemist:

First, the acquirement of habits of thoroughgoing cleanliness and systematic procedure. I see held up in horror the hands of many a man who has for years taught—by example if not by precept—that a little of dirty beakers, retorts, test tubes, etc., is necessary to create a proper "atmosphere" for work. But of the men whom I have observed in practice the most efficient were those whose work was reduced to a system, who kept every reagent bottle and piece of apparatus clean and in its appointed place, and who consequently performed their work quickly and well. Surely cleanliness and order are two of the most important factors in the

achievement of analytical success, and the first day of instruction in practical chemistry is not too soon to begin training along these lines.

Second, a general survey of the work to be done by each student during the college year, and the drawing up of a systematic plan of operations; a study of the different determinations, with a view to running several at one time, in order that every moment may be fully occupied.

Third, not only the most accurate methods required in practice, but, even to a greater extent, the quick methods. The student should know the error permissible in such work, and should govern his weighing, filtration, etc., accordingly. Many a college graduate required to determine the iron in a slag, with an error limit of one part in 100, will weigh his sample to one part in 5000, and actually spend longer in the weighing than a practical chemist would require for the determination. This is on a par with reporting to hundredths of a per cent results not closer than one per cent to the correct value.

Fourth, the helps to rapid work. These consist of both mechanical devices and a knowledge of conditions favorable to the performance of the various operations. College laboratories spend much for expensive apparatus which is seldom used, while but a small sum would be required to provide the students with numerous devices which would greatly facilitate rapid work, and which are to be found in most works laboratories. Descriptions of many such are to be found in the technical publications.

As an example of the desirability of studying conditions I will mention three helps to rapid filtration which were not sufficiently impressed upon me at college: hot precipitation, with subsequent boiling; the use of the suction pump for some precipitates, and its avoidance for others; the selection of the proper filter-papers for various precipitates and conditions.

Fifth, the development of the student's judgment, when he has gained some degree of familiarity with analytical methods. Though required to make analyses for definite elements or radicals, he should be allowed considerable liberty as to the choice of method. This choice is extremely important, being influenced by the degree of accuracy required, the time allowed for the determination, the modifications to be made in the presence of interfering elements, or by the fact that several determinations are to be made in the same portion.

To illustrate this point, the electrolytic method for copper is rightly valued for its accuracy, but as described in a leading text-book the presence of lead, arsenic and bismuth is assumed. The chemist who would deliberately choose that method, as described, in the known presence of these elements, is in dire need of instruction in the choice of method.

Something like the following might be used as a guide in the determination of copper:

(A) For accurate work.
  (1) When ores do not contain interfering elements, electrolytic.
  (2) In presence of As, Bi, etc., iodide.
(B) For approximate work.
  (1) Ores, slags or tailings under 1.0 per cent Cu, colorimetric.
  (2) Mattes, cyanide.
  (3) Medium or high grade ores.
    (a) No Zn, etc., cyanide.
    (b) Zn, As, etc., present, shortened iodide or permanganate.
    (c) If no interfering elements, electrolytic, as little manipulation is necessary.

Sixth, the value of considerable familiarity with such determinations as those of silica, sulphur and the common metals (both accurate and approximate methods) rather than a single determination of a very long list of elements. The chemist who can determine a few elements well should be able, with the assistance of a good text-book, to get satisfactory results for any. The intensive training will make a deeper mental impression and produce a greater self-confidence than the extensive. At present the young graduate is likely to think that he has been taught the best method for each element, but he may find that his method is far from the best under the practical conditions which confront him.

PRACTICAL APPLICATION OF THE ABOVE SUGGESTIONS

No cast-iron rules can be laid down as to which methods or procedure should be followed in works laboratories. In each plant the chemist must be governed by local conditions in all that he does. For this reason, if for no other, the example which I will give of how the principles enunciated above have been applied in the laboratory of one copper smelter is not intended to be taken in any sense as a model, but simply as an illustration. And it is probable that another series of chemists might have differently arranged the same work to secure equal or greater efficiency. Of the succeeding chemists who have contributed towards the goal of greatest speed with all the accuracy necessary I wish to give especial credit to George M. Lee.

Determinations and accuracy required: Cu on sixteen samples of blast furnace slag to 0.02 per cent; SiO$_2$, Fe and CaO on an average of the same to 0.2 per cent; SiO$_2$ (insol.) to 0.5 per cent and Cu to 0.1 per cent on each of nine samples of converter slag; Cu to 0.5 per cent on sixteen samples of matte.

Plan of work: Errors will be allowed in weighings, but in no case must these exceed one-fifth the permissible error in result. Cu in blast furnace slags, running about 0.20 per cent, will be estimated by color, in converter slags (1-2 per cent), and mattes it will be determined by the cyanide method. Only one evaporation is required for SiO$_2$; the result on the blast slag will be about 0.6 per cent lower than the true SiO$_2$, those on converter slags a little high, due to imperfect decomposition. Fe will be by the bichromate method—the permanganate would be equally good—CaO by the permanganate. The SiO$_2$ and CaO are the longest determinations, so will be started first and given closest attention. All the others are fairly short. Only sixteen cyanide burettes are available, so mattes and converter slags will be run separately for Cu.
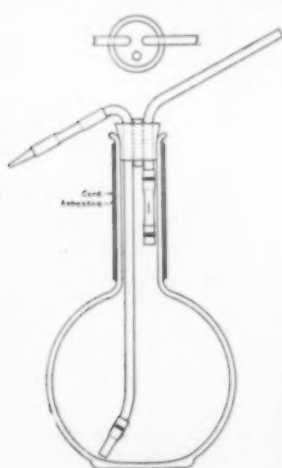
Fig. 1 - Sprinkler
Made of tin or lead

Fig. 3 - SnCl₂ Bottle
To use, invert.

Fig. 2 - Wash Bottle

For wash bottle, bore three holes in rubber stopper, as shown, using wet borer and starting holes at small end. For valve, tie rubber tubing securely to lower end of mouthpiece, fold over loose end and tie tightly. Cut two quarter-inch vertical slits on opposite sides—one is shown. Tubing in bottom allows emptying bottle without blowing air over. Wrap pneck with wet sheet asbestos, covering with layer of heavy cord, drawn tightly. To use, place thumb over open tubing, blow, then remove thumb to release pressure. Constant blowing not necessary.

Mechanical equipment: (That which is in common use in all laboratories will not be mentioned.) Sufficient three-heat electric hot plates to accommodate all the work at once. Overhead heater for water, with bottom outlet, rubber tube and glass tip for washing precipitates. Overhead tank for cold water, with siphon outlet and $\frac{3}{8}$-in. rubber tube terminating in sprinkler device (Fig. 1) for making quick dilutions in casseroles and beakers without spilling liquids in latter. Overhead ammonia bottle with siphon, and rubber tube reinforced with friction tape. Special wash bottle (Fig. 2), with valve to prevent hot water or acid fumes getting into mouth of operator and to keep up pressure without continuous blowing. Special bottle (Fig. 3) for the addition of $SnCl_2$ in small quantities. Cyanide burettes without pinchcocks, but with rubber tubing containing glass beads as valves, and glass tips. Siphons for filling burettes from elevated bottles or carboys. Titration plate of paraffin and zinc oxide—cleaned, when necessary, with gasoline. Shaving-stick box with small holes punched in top, containing crystals of $K_3FeC_6N_6$ for making up small amounts of solution for Fe titration. Dropping bottle, painted black, for the preservation of easily decomposable "slag acid" (see below), and for the addition of small quantities of it when surplus acid has to be evaporated—SiO_2 determinations. Wooden tray to hold eighteen 400-c.c. beakers or equivalent. Enamelled saucers, in place of sample envelopes, for matte and slag samples, each bearing pasted label showing number of furnace or converter and shift to which sample belongs.

Routine of operations: Place on tray ten 3-in. casseroles, with watchglass covers, one 250-c.c. beaker, and nine 400-c.c. beakers. Out of each blast furnace slag sample take small spoonful of slag, mixing well together on rolling cloth. Weigh out of this average 0.5 gm. (within 0.001 gm.) into 250-c.c. beaker for Fe and 0.5 gm. (within 0.0005 gm.) into casserole for SiO_2. Weigh 0.5 gm. (within 0.002 gm.) of each of converter slags into casseroles for SiO_2, and 2.0 gm. (within 0.01 gm.) of same into 400-c.c. beakers for Cu. From dropping-bottle add to each casserole 1-2 c.c. "slag acid" (mixture of four vols. HNO_3, one vol. HCl, two vols. H_2O), cover and set on plate at high heat. Into each 400-c.c. beaker pour 10-12 c.c. HNO_3 and set on plate at medium heat without covers. From wash bottle pour 5 c.c. boiling H_2O into 250-c.c. beaker, and while rotating beaker on hot plate add slowly about 5 c.c. HCl. With glass rod loosen any SiO_2 from bottom and heat one minute longer. Remove, add three drops $SnCl_2$, dilute to 100 c.c. with cold water, add 25 c.c. saturated $HgCl_2$ solution. Let down solutions in all burettes to zero. Place beaker of saturated oxalic acid solution on asbestos on plate. Partly remove covers from casseroles, now almost dry. Shake a few crystals $K_3FeC_6N_6$ into beaker, add 25 c.c. H_2O, transfer to dropping-bottle, put dozen drops on spot plate. Titrate Fe—solution reading directly in percentage. Put eighteen colorimetric bottles under funnels and fold a 15-cm. S. & S. No. 595 filter paper into each funnel, afterwards moistening. Remove dry casseroles from plate. To each 400-c.c. beaker on plate add from sprinkler 20-30 c.c. cold water (making cool enough to handle with bare hands), remove, dilute similarly to 200 c.c., add 10-12 c.c. NH_4OH (from siphon), stir with rubber-tipped glass rods (using both hands), place under KCN burettes, add 1.0 c.c. to each, again stir. Pulverize well the dry residues in casseroles, replace on plate. Make second addition of KCN—in amount according to depth of color. On tray place eighteen $3\frac{1}{2}$-in. casseroles, into each weigh 1.0 gm. (within 0.01 gm.) furnace slag, including as standards two previously determined by

electrolysis to contain 0.19 and 0.21 per cent Cu. To each add 10 c.c. HCl and set on plate at medium heat. Remove silica casseroles. Make third addition of KCN (little will be required). On tray place sixteen 400-c.c. beakers and into each weigh 0.5 gm. matte (within 0.001 gm.). To each color copper casserole add 2-3 c.c. HNO_3, turn heat off plate. To each matte beaker add 10 c.c. HNO_3 and set on plate at medium heat. To each SiO_2 casserole add 10 c.c. HCl, leaving off plate. Make final addition of KCN, if any required, read burettes, adjust to zero. Attach filter pump, fold carefully ten 11 cm. No. 1F Munktell's filter papers. To each SiO_2 casserole add 25 c.c. H_2O, set on plate at high heat. Dilute colorimetric determinations to 100 c.c. each, stir with rubber-tipped glass rod (use same for all), loosening well from bottom. Slightly dilute mattes (to cool), remove from plate, dilute to 200 c.c. To each colorimetric casserole and matte beaker add NH_4OH to precipitate Fe and 5 c.c. additional. Stir all well. Place matte beakers under burettes. Filter silicas by suction, washing each once with HCl from dropping bottle or wash bottle and three times with hot H_2O. Place silicas in annealing cups. Transfer first filtrate (from blast furnace slag) to 400-c.c. beaker, retain others in suction flask. To first add NH_4OH till alkaline and 5 c.c. additional. Place on plate at high heat. Place annealing cups in front of muffle—just below red heat. To each matte beaker add KCN, stirring constantly, till the color changes to light brown. Pour hot oxalic acid solution into boiling filtrate from SiO_2 till CaO is precipitated as oxalate. If very little acid be required, either add 1.0 gm. ammonium oxalate or reprecipitate Fe with NH_4OH and redissolve in oxalic acid. Move annealing cups to hottest part of muffle. Make second addition of KCN to mattes, according to color. Filter slags for Cu into colorimetric bottles, washing precipitates twice. Make third addition of KCN. Filter CaO through 12.5 cm. Munktell's No. 1F paper, washing nine times at intervals. Put 100 c.c. H_2O and 10 c.c. H_2SO_4 in original 400-c.c. beaker and set on hot plate. Fill colorimetric bottles to mark and shake. Remove annealing cups from furnace. Compare Cu in slags with standards. Make last addition of KCN to mattes (if any necessary) and read burettes. Drop filter containing calcium oxalate into boiling H_2SO_4 solution and titrate at once with $KMnO_4$. Weigh silicas.

An hour and a half is good working time for one chemist on the above, though it has been done occasionally in an hour and a quarter. While this is not as fast work as done by many chemists running determinations of one kind only, it may be sufficiently in advance of that of the student to illustrate the point that I wish to emphasize—that by the adoption of quick methods, the use of convenient equipment, the concurrent determination of several elements or radicles, and a careful planning of all work, it is possible to accomplish considerable even in a time as short as one of the college laboratory periods.

In conclusion, I will state my belief that one year's practical experience before or during his college course will give the average man a new sense of the opportunity which is his during his student life, and the growing insistence of instructors upon such practical work is one of the encouraging signs of progress in the training of technical men.

Grand Forks, B. C.

Government Radium Tests.—In October, 1916, the United States Bureau of Mines received the largest quantity of radium to be tested for a single month. The total value of the radium was $77,000. Up to date the aggregate value of radium tested by the bureau is above $1,000,000.

Synopsis of Recent Metallurgical and Chemical Literature

Metallography

Grain Growth Phenomena in Metals.—In a paper to be read before the members of the American Institute of Mining Engineers, at the February, 1917, meeting of this society, at New York, ZAY JEFFRIES discusses factors influencing fast growth phenomena, fast growth phenomena in low-carbon steel, and effect of cold deformation on uniformity of orientation of original grains.

Under the first heading come the effect of rate of heating, the resistance to grain growth, influence of grain size prior to deformation temperature and deformation gradients, and the influence of the thickness of the sample. The conclusions drawn on the effect of the rate of heating are: The time factor is always a governing factor in the first stage of grain-growth; if the time of heating is short, the germinative temperature is raised. The formation of large grains in metals may occur at relatively high temperatures when the rate of heating is rapid.

The resistance to grain growth is divided in two parts: First, the resistance offered by the pure predominating constituent and second, the resistance offered by impurities. At the germinative temperature the present of impurities favors the formation of coarse grains. As the resistance to grain growth increases, the germinative temperature increases and the time necessary to form large grains decreases rapidly. As a general rule, other conditions being equal, the finer the existing grains at the germinative temperature, the greater will be the tendency toward selective grain growth.

In a pure metal with a given amount of cold deformation, the grain size before deformation will have a marked effect on the selective grain growth during annealing. If the initial grain size is large the grain fragments formed during annealing will also be large and vice versa. If the grains are initially large the fast growth phenomena may be almost completely masked. The formation of large grains at the germinative temperature is dependent upon the evenness of the grain size with a temperature gradient or an even temperature with a deformation gradient or any combination of the two. The difference in temperature of recrystallization furnishes the cause for selective grain growth due to deformation gradients. When the total average cold deformation exceeds about 30 or 40% reduction in area of the metal, the number of germinative grains formed during normal muffle heating may approximately equal the number of equilibrium grains for the maximum temperature reached during annealing. The effect of thickness of section on grain growth in metals is general. In wires of small diameter the author has found two regions in which fast grain growth takes place. One occurs at the germinative temperature and the other occurs at most any temperature above that, the time varying inversely as the temperature. At the second temperature the large grains form invariably near the surface of the sample. The formation of large grains in wires of small diameter may be invariably checked by the introduction of impurities, such as non-metals. The introduction of impurities has the same effect as lessening the diameter of the wire.

The author then applies the above mentioned facts to the theory of grain growth in low-carbon steels. Here, he states, that the formation of gases in metals are also to be considered as offering resistance to grain growth. This is due to the fact that gases in solution or mechanically entrapped affect the annealing temperature after cold deformation, as Rose and Phelps have demonstrated.

According to Prof. Howe, the uniformity of orientation after cold deformation is greater within the individual original grains than between adjacent grains. This, Jeffries claims, is true for the majority of the cases, but it also must be considered, that in cold-deformed metals there is sufficient difference in orientation within the original grains to be the chief cause of recrystallization on annealing. That this may not generally be observed is due to, first, that the diameter of the individual grains in which we can study etching pits is usually not more than 0.0002 in. and, therefore, any difference in orientation of the grains is not readily visible; and secondly, the sections which are usually examined in deformed metals are the most conducive to similar etching tints.

Lead

Matte Granulation at Herculaneum, Mo.—S. PAUL LINDAU and HENRY B. SMITH will present a paper under the above title at the February, 1917, meeting of the American Institute of Mining Engineers at New York. The St. Joseph Lead Co., at Herculaneum, Mo., have decided to granulate the matte obtained at that smelter in order to eliminate a large amount of labor and save the crushing.

The matte is tapped into 6 cu. ft. iron ladles. These are transported to the granulating plant by electrically driven overhead cranes. The matte is received in a cylindrical container, which in reality is a specially devised Traylor converter without the tuyeres and has a 20 in. opening at one end for the flue and oil burners. It may be tilted and is lined with a 9-in. lining of magnesite brick. The consumption of 18° to 20° Be. crude oil is 250 gal. per 24 hr. or 2 to 2½ gal. of oil per ton of matte granulated. Thirty lb. of air are supplied per burner for atomizing the oil.

The liquid matte is granulated by pouring it through two superimposed flat jets of water shooting horizontally into a concrete tank lined with cast-iron plates. The stream of matte is accurately directed on to the jets of water by means of a pouring box. This box is lined with common brick and the matte is poured into it by revolving the container. A dewatering drag conveyor removes the granulated matte from the tank, the floor of the latter sloping at an angle of 30° towards the trough in which the conveyor operates. The conveyor elevates the matte over the slag track and discharges into railroad cars, which are weighed, the contents sampled and dumped into roaster bins. A V-shaped settling box takes the overflow of the tank proper and saves the coarser slimes, while the fine slimes are collected in a series of settling tanks. An excelsior filter finally cleans the water from the end settler, which then goes to the circulating pond. Two series of settling tanks are used, one lying idle while the other is in operation.

Under the old regime the cost of matte handling including screening, was $1.43 per ton. Granulation costs only $0.75 per ton, thus giving a saving of $0.68 per ton of matte granulated. The following two tables will be of interest:

Summary

Matte granulated per 24 hr., tons	100
Rate of pouring, cubic feet per minute	3.3
Oil consumed per 24 hr., gallons	250
Oil per ton of matte granulated, gallons	2.5
Water used per minute (under head of 40 ft.), gallons	100

Screen Analysis on Granulated Matte

Inch-Mesh	Per Cent
On ¼	5
On 3/16	4
On ⅛	14
On 1/16	35
Through 1/16	42
	100

Pitch

Coal Tar Pitch.—*The Iron and Coal Trades Review* (London) gives the following information on pitch taken from a circular sent out by the London Coke Committee: "The prevailing condition of scarcity and high cost of steam coal naturally direct attention to the fuel value of the huge accumulations of pitch which now tend to encumber the working up of high-explosive munitions of war at coke oven, gas works and other tar distilleries. The total yearly production of pitch at the 248 tar works registered in 1915 has been estimated at over 1,000,000 tons. With the sudden closing of the Continental market in August, 1914, and the continued restrictions on export trade, hitherto the chief method of disposal, the outlook for pitch and, incidentally, coal tar in the near future is extremely problematical. Prospective new outlets for use in gas and briquette making have not yet materialized to any appreciable extent, and with the increasing demand for coal tar derivatives which may be confidently anticipated, the possibilities of the fuel field as an outlet for surplus pitch should be critically examined. Considered as a fuel for steam boiler and other furnaces, pitch has distinctly attractive features. Not only is its calorific value—viz., 15,000 to 15,500 B.t.u. per pound—higher than that of the best quality Welsh steam coal, but its present price in the Midlands and London district respectively is only about one-third to one-half that of such coal; moreover, it is practically pure carbon, and ash and moisture free, so that in whatever proportion it may be added to other staple fuels, more than an equivalent amount of such fuel may be released for sale or export. The relatively high price realized for pitch has in the past naturally precluded its direct use as fuel. Experience in and special appliances of proved utility for its use directly as fuel are therefore lacking, or at least unknown to the would-be user. Recent experiments in this direction which have had for their object the provision of a simple and inexpensive appliance in the form of a specially designed firebar are therefore of some interest. The chief difficulty experienced in attempting to burn pitch has been the low fusing and volatilizing temperature common to all pitches and the consequent tendency to separate carbon in the form of dense smoke. Compared with average bituminous coal containing 28 per cent volatile matter, pitch contains about 55 per cent, the remainder being practically pure amorphous carbon. The claim is made that by means of this special firebar, coal tar pitch may be consumed in conjunction with coke with considerably less than the ordinary amount of smoke observed at the chimney of a coal-fired boiler. The *modus operandi*, which has been tried with some success in certain gas works boilers, is to substitute a number of "pitch" bars for an equivalent number of existing firebars in a boiler furnace fitted with steam-jet, forced-draft apparatus of ordinary construction. Pitch, broken to any convenient size, is fed on to the pitch bars, where the heat of the surrounding fire causes it to collect and volatilize; the rate of such volatilization being controllable by means of the special formation of the pitch bars, within limits which insure practically smokeless combustion. The partially coked residue remaining after the more volatile constituents have been burned off is periodically raked onto the rear portion of grate, where its combustion is completed.

Large Sugar Beet Crop in 1916.—Preliminary returns from the beet-sugar factories indicated a production of 918,000 short tons of sugar during the 1916 campaign. The area harvested was 680,000 acres. The sugar production exceeds the highest preceding crop in 1915 by 44,600 tons.

Recent Metallurgical and Chemical Patents

Caustic Soda

Manufacture of Caustic Alkali.—A patent has been granted to EDGAR A. ASHCROFT of London, England, on a process of producing anhydrous caustic alkali by treating fused alkali metal (produced in an electrolytic cell from an alkali salt in a fused state) with ammonia in one cell to produce an amid. The amid is run into a second cell and heated with steam, producing anhydrous caustic alkali and free ammonia. The product from the second cell is run into a third cell into which the free ammonia from the second cell and steam are passed, where the reaction is completed and the ammonia dried. The dried ammonia is returned to the first cell for use again. (1,198,987, Sept. 19, 1916.)

Phosphoric Acid

Electric Furnace for Phosphoric Acid.—Improvements in an electric furnace for producing phosphorus and phosphoric acid vapors from phosphate rock are patented by INGENUIN HECHENBLEIKNER of Charlotte, N. C. (assigned to Southern Electrochemical Company). The furnace is adapted to produce phosphoric acid from a mixture of phosphate rock, siliceous material and carbon, the gases consisting of phosphorous vapor, carbon monoxide and phosphoric acid. The improvements consist in using the gases to preheat the charge and in improved cooling devices. (1,202,837, Oct. 31, 1916.)

Tungsten

Metallic Tungsten.—An electrolytic method of producing metallic tungsten has been patented by FREDERICK G. KEYES and ROBERT B. BROWNLEE of East Orange, N. J., and assigned to the Cooper Hewitt Electric Company. In this process tungsten trioxide is subjected to a temperature of 2000 deg. C., in an electrolytic bath with a rotating tungsten cathode and an anode of sintered tungsten. The electrolysis produces a lower oxide of less resistance, permitting the passage of the current readily. The crucible is of tungsten or of noncontaminating material. (1,202,-534-5, Oct. 24, 1916.)

Tin

Electrolytic Recovery of Tin.—A patent has been issued to ALBERT E. BATTLE of Aldgate, London, England, on the electrolysis of tin and its salts. The process is applicable to the production of tin from ores or the recovery of tin from tinplate. The electrolyte consists of tin or a salt of tin such as the sulphate or protochloride dissolved in ortho phosphoric acid, either concentrated or dilute. The tin ore or scrap is used as the anode in this solution. For a good deposit of tin the patent states that 50 grams per liter of tin salt dissolved in 10 per cent phosphoric acid will be satisfactory. (1,202,149, Oct. 24, 1916.)

Cellulose

Electrical Treatment of Cellulose.—In a patent of ALBERT L. C. NODON of Bordeaux, France, it is proposed to treat wood or other forms of cellulose electrically in order to preserve them and increase their strength by first immersing for a short time in a solution of zinc chloride, sodium chloride or other conducting salts, and then subjecting to an alternating current of low frequency. The process is applicable to wood, textile plants, artificial silk, fabrics, paper paste, paper, etc. (1,198,867, Sept. 19, 1916.)

Electric Furnaces

Improvements in Birkeland-Eyde Furnace.—A new method of introducing and withdrawing the gas in a

Birkeland-Eyde nitrogen-fixation furnace, which is claimed to increase the output is patented by CARL O. A. DÖVLE of Notodden, Norway, and assigned to the Norsk Hydroelektrisk Kvaelstofaktieselskab, of Christiania, Norway. In general the gases have been conducted through electric arc furnaces of the flame disk type along the whole flame surface, either introducing the gases at the center and withdrawing them at the periphery or vice versa. The present patent proposes to conduct the gases over only a small portion of the flame, as shown by the illustration Fig. 1 in which A represents the furnace, B the flame disk, C the inlet openings and D the outlet openings for

FIG. 1—ELECTRIC FURNACE FOR PRODUCING NITRIC ACID FROM AIR

the gases. A cooling coil shown at E may be used to augment the cooling effect (1,194,606, Aug. 15, 1916) in case it is desired.

Electric Arc Furnace.—According to a patent of EMIL EDWIN of Christiania, Norway, (assigned to the Norsk Hydroelektrisk Kvaelstofaktieselskab) greater

stability can be produced in flame arc nitrogen furnaces of the Schönherr type, if no ground connections are made. The long stable arcs in electric furnaces of the Schönherr type are generally maintained between an insulated electrode and a cooled tube, which is connected directly to the flame tube and the outer parts of the furnace. Fig. 2 shows a drawing of three furnaces so arranged. The insulated electrodes are shown at D connected to a three-phase system, and the furnaces are represented by A, B and C. The flame is maintained between

FIG. 2—THREE-PHASE ARC FURNACE SYSTEM

the lower electrodes and the interior wall of the coolers H. Previously these coolers and the flame tube were grounded. According to the present invention they are connected together by connectors I as shown but are insulated from the ground. It is claimed that this arrangement gives a better stability of the arcs. (1,193,-882, Aug. 8, 1916.)
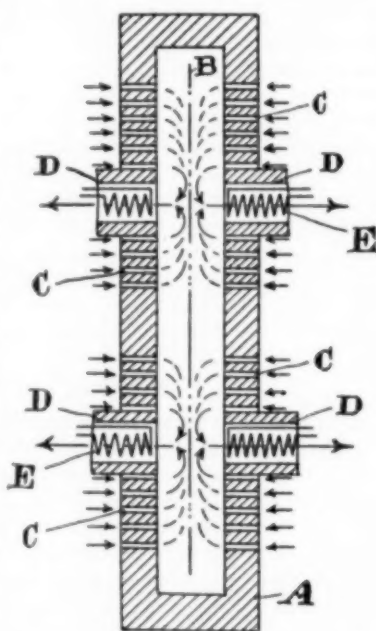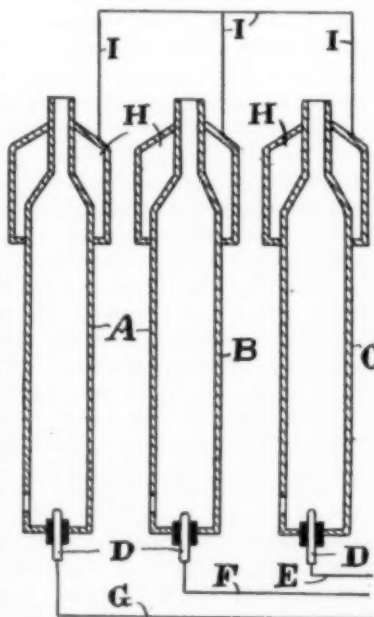
Constant-Current Closed-Circuit Arc Welding System

Present arc welding practice is based on operation of arcs from constant-potential circuits, and since arcs operated under these conditions are unstable, it is necessary to use in series with each arc a ballast resistance.

In the early days, comparatively high-voltage circuits were used and enormous quantities of energy wasted in resistance. Later, as arc welding became of greater industrial importance, generators were constructed especially for the purpose, and the voltage was made as low as possible, until finally it has settled down to from 60 to 70 volts. Automatically controlled resistance which changes with the value of the current, permits the use of a lower voltage, but the arc still has the constant-potential characteristics.

A normal welding arc consumes about 22 volts. However, depending upon the operator and upon the work, it may vary from 18 to 28. Therefore, any voltage pro-
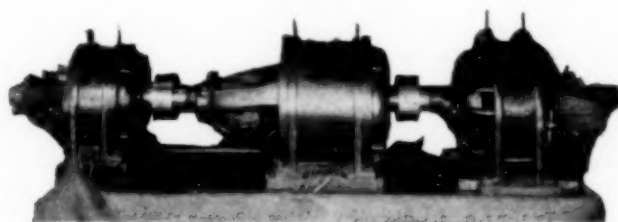
FIG. 1—SELF-REGULATING WELDING GENERATOR

duced by the generator in excess of this must be absorbed in resistance and wasted.

The constant-potential arc when operated in multiple with other arcs, requires a separate circuit from the generator end of the line, or at least from a point in the distribution system where the voltage regulation is close, otherwise the coming on and the going off of the various arcs will disturb the regulation to an intolerable degree.

On account of the expense of low-voltage distribution circuits for constant-potential arcs, practice has drifted toward the single-arc unit, portably mounted.

The Electric Welding Company electric welding contractors who have been in electric welding business for nearly ten years, developed in their practice a new system of arc welding, and in order to place this system on the market, organized the Arc Welding Machine Company as a separate corporation. The Arc Welding Machine Company has perfected the system now known as the constant-current closed-circuit system, which operates arcs in series.

This method has all the advantages of series distribution, namely, the size of wire is uniform throughout the system and carries a uniform current, independent of the length of the circuit as well as of the number of operators. The circuit is simply a single wire of sufficient cross-section to carry the current for one arc, run from the generator to the nearest arc, from there to the next, and so on back to the generator. Wherever it is desired to do welding, a switch is inserted in the line, and a special arc controller provided with suitable connections plugged in across the switch, whenever work is to be done. These controllers may be made portable or permanently mounted at the welding station.

The generator shown in Fig. 1 is a special machine and consists of two units. The generator proper which furnishes the energy for welding; and the regulator, which automatically maintains the current at a constant-value. The regulator is excited from a separate source, and by varying its excitation with an ordinary

field rheostat, the main welding current may be set at any value within the range of the machine that is desired, and once set it will automatically maintain that value.

Each arc that is operated on the system is equipped with an automatic controller shown in Fig. 2 which serves two essential purposes as follows:

1—It maintains at all times the continuity of the circuit, so that one arc cannot interfere with any of the others when it comes on, or goes out of, the circuit.

2—It controls automatically the heat which can be put into the metal of the weld.

The current through the arc, together with the size of pencil, determines the flow of metal

FIG. 2—AUTOMATIC ARC HEAT CONTROLLER FOR CONSTANT CURRENT CLOSED-CIRCUIT OPERATION

from the pencil, and this current is adjusted by shunting any desired portion of the main current around the arc. The regulation characteristic of the arc is adjusted by a series parallel resistance, which is patented.

For a given flow of metal through the arc, the temperature of the metal is determined by the length of the arc, that is, by the voltage. With this controller, the length of the arc limited by the voltage is adjusted to suit the work and the operator, and if exceeded, the arc is short-circuited automatically and remains short-circuited until the welder is ready to begin again.

Provision is also made for stopping the arc at will without lengthening it. Therefore, with this system it is impossible to draw a long arc and burn the metal, and most important of all, the arc is not broken when the welding operation is stopped, but is killed by a short-circuit which is placed across it.

Stopping an arc by short-circuiting and limiting the heat production in the same way is also patented. A great step in advance has been made by short-circuiting the arc instead of breaking it; because it is impossible to avoid leaving a crater with pin-holes by any other means than reducing heating of the metal, and this is the most effective method of doing it.

On account of the fact, that the arc heat is automatically controlled and limited, it is possible to use a lower grade of labor in welding operations with this system.

The number of arcs that can be connected in series is limited only by the voltage, and up to the present time, 12 is the maximum for which machines are constructed. Fig. 3 shows the wiring diagram for a system containing three arcs.

A New Non-Corrosive Insulating Compound

A new product with desirable properties is being placed on the market by the Diamond State Fiber Company of Bridgeport, Pa., under the name of condensite-cellulac. It is made by curing fiber and condensite together in one operation and combines the properties of these two substances. It is anhydrous and non-hygroscopic and is impervious to the action of oil or ordinary acids or solvents. It also combines toughness with resistance to the temperatures ordinarily encountered in insulation work.

The chief feature of this material is that it can be made in sheets which are homogeneous and not made up of laminations. It is weather-proof and can be used in
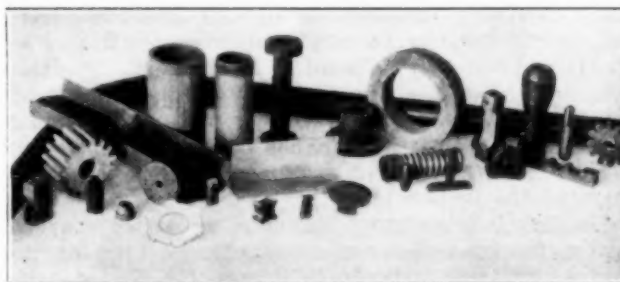
ARTICLES MADE OF CONDENSITE-CELLULAC

apparatus subject to unfavorable conditions of moisture, oil, etc.

It is furnished to the trade in merchantable shapes—sheets, rods, tubes, etc., and is readily machined. It may be formed into very thin sheets (0.015 in. or less) with remarkable accuracy to gage, thereby furnishing an excellent diaphragm material. It is also supplied shaped to customers' specifications. The work as thus supplied is ready for use, having been hardened and made insoluble and infusible by the application of heat.

It is also possible to supply it in the soft uncured state, permitting of its being hardened in the place where it is to be used and thereby formed to fit in spaces or locations with great accuracy. Thus, for instance, gaskets for hot lines, steam, hot water, compressed air, etc., may be accurately fitted to rough flanges and cured in place by the heat of the line, or by applying a certain amount of external heat until the material is hardened.

FIG. 3—WIRING DIAGRAM CONSTANT-CURRENT CLOSED-CIRCUIT SYSTEM

Commercial and Industrial Preparedness in Foreign Countries

The whole field of commercial and industrial preparedness for foreign trade promotion, has received increased attention in every important nation of the world since the outbreak of the European war in 1914. The British Government immediately gave instructions to its consular representatives, commercial attaches, and trade commissioners in all foreign countries and the colonies to submit reports on o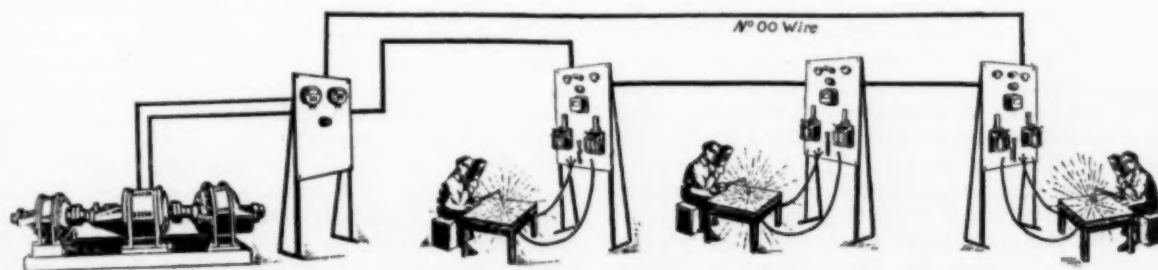pportunities for British trade occasioned by the cutting-off of the German and Austrian supplying markets. A vast quantity of samples of German and Austrian merchandise which had previously been supplied for use in these markets, was sent in by the British Government representatives, and was placed on display in London. The manufacturers of Great Britain have not only been making merchandise to supply the needs of the army and the government since the war began. They have also been going after foreign markets, and the Commercial Intelligence Branch of the British Board of Trade (an office corresponding to the Bureau of Foreign and Domestic Commerce in Washington) has given them the heartiest of co-operation. Sample exhibits, reports on definite trade opportunities, all sorts of confidential information concerning openings in foreign countries, have been provided by the Commercial Intelligence Branch to an extent previously unheard of in England. The fact that British exports have kept up to such a high level despite the loss of several very important consuming markets because of the war, has been in no small part due to the Government assistance which has been rendered the British trade.

Similarly, in the other European countries engaged in war, foreign trade promotion by the government has been a noticeable feature. In France, the National Office of Foreign Commerce has substantially increased its activities, encouragement has been given to French Chambers of Commerce abroad, and everything in the way of government trade promotion has taken on new life. There has been more active interest in foreign trade, that is, in the export trade in France during the past two years, than there ever was before. At this time there is in this country an important merchant from Paris representing a group of the biggest French manufacturers of fine textiles and wearing apparel. The French government has had a commission of its leading business men visit the United States to study trade opportunities and to make arrangements for increasing commerce between the United States and France during and after the war. In Paris, there has been held a so-called "Reconstruction Exposition." In Lyons, a determined effort has been made to develop the Lyons Fair to rival or even replace the Leipzig Fair.

Of course, industrial and commercial preparedness on the broadest lines has been the subject of the great Paris conference between representatives of England, Belgium, France and Russia, and other allied governments.

In a corresponding manner there has been held the Dresden conference of representatives of the Central Powers and their allies. This conference like the Paris conference had for its purpose the formulation of plans for industrial and commercial preparedness during and following the war.

Germany and Austria have both had substantial government organizations for promoting foreign commerce and while the export trade of these countries has languished somewhat during the war, interest in developing export trade after the war has not in the least diminished. The business men are working right with the government to see that all possible preparation for intense commercial competition is made.

In Russia, Spain, Italy and Japan, likewise, all possible means for increasing and stimulating present and potential foreign trade are being availed of. Even some of the South American countries that we think of only as suppliers of raw materials and purchasers of manufactured commodities have been able to develop export business in other manufactured goods and are now preparing to extend their business in these commodities.

In the manufacturers and merchants of our country are going to hold the foreign business that they now have, and are going to keep up their end in the commercial competition that is bound to follow the war, it is absolutely necessary that our Government and our business men through their organizations, should leave no stones unturned to be thoroughly prepared. In addition to commercial and industrial preparedness on the part of the business men themselves, we should have the advantage of a better rounded-out service in the Bureau of Foreign and Domestic Commerce, which has done, and is now doing excellent work.

Methods of distribution in South America, Russia and China, involve a study of export and import houses; the position of the foreign manufacturer; different types of middlemen; and different retail agencies, including the department store, chain store, mail order house. and regular retailer.

The investigations into advertising in South America, Russia and the Far East, involve a study of different mediums, including trade papers, newspapers, and other periodicals, cards, billboards, window display and electric sign advertising, with careful attention to the customs and traits of the different peoples.

The handbooks on commercial and industrial conditions to be prepared for Japan and the Dutch East Indies, and Africa, should afford the American business man knowledge of fundamental conditions in these countries that he does not possess in convenient form at the present time.

It is interesting to note that among the investigations to be undertaken by the Bureau of Foreign and Domestic Commerce in the year 1917-18 is one into chemicals, dyes, paints and varnishes for South America.

An Improved Automatic Liquid Weighing Scale

The purpose of any liquid meter is to automatically measure and to record the amounts or quantities of liquids used. This can be done either by simultaneous determinations of the volume and density or by weighing. In determinations of quantities by the first method the density is usually disregarded. Liquid meters may then be divided into two main classes viz.: Volume type machines and weight type machines.

A machine belonging to the latter class is made by the John Simmons Co., 108 Center Street, New York City, and is known as the Leinert automatic gravity scale. Fig. 1 shows a photograph of this machine and Figs. 2 and 3 show sectional drawings. It is used for measuring by weighing such materials as water, oil, sugar juice, ammonia, brine and other liquids, and is not affected by the temperature.

Referring to Fig. 2, the apparatus consists of two measuring tanks of equal size A-1 and A-2, fitted each at one end with one or more siphon pipes C and at the other with weights D. The tanks work on the knife edges, "B," which are located at less distance from the counter weights D, than from the siphon pipes C. The liquid to be measured flows through the inlet pipe E.

passing along the deflector F into either tank, for instance as shown, in Fig. 2, into the left hand tank A-1. The weights D are so adjusted that the tanks will remain in a horizontal position until they contain a certain definite weight of liquid then they will tilt into the position shown by the dotted lines on Fig. 3, and the
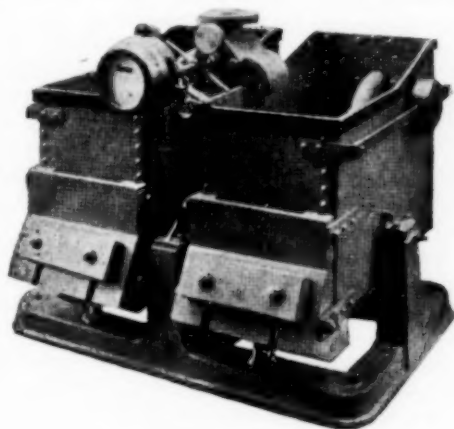

FIG. 1—GENERAL VIEW OF SCALES

liquid will begin to flow through the siphon pipe C. After this flow has been started and the level of the liquid in the tank has fallen sufficiently, the tank tilts back again to its original position by the influence of the weights D the siphon continuing in action until the tank is emptied. As each tank assumes the position, indicated by the dotted lines Fig. 3, it suddenly tilts the deflector F over, so that the liquid, instead of continuing to flow into the tank A-1, begins to flow into the other tank A-2, when the same operation as already
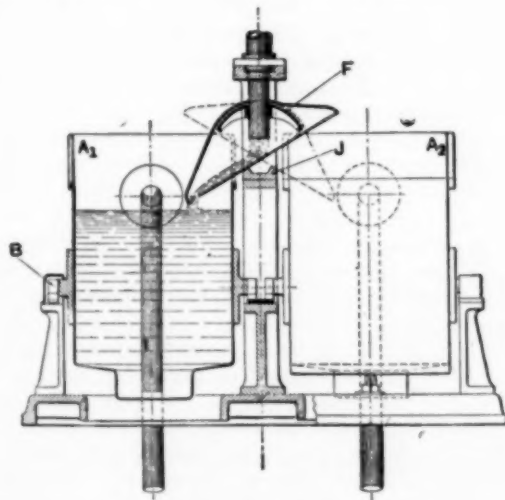

FIG. 2—FRONT SECTIONAL VIEW

described is repeated and continued. It will thus be seen that both tanks are filled automatically with fresh liquid, while the measured liquid runs away into a reservoir, or other receptacle as required. As each tank tips the number of pounds contained is registered on the counter G, which is actuated by the deflector F.

When either tank is in a horizontal position the deflector F rests upon the support J, not touching the tanks, therefore the time of tipping and the accuracy cannot be affected, either by the weight of the deflector, or by the pressure of the running liquid in the deflector, or by the resistance in the mechanism of the counter.

In cases when the rate of flow varies considerably, the only source of inaccuracy is the varying quantities

of liquid, which falls into the tank during the time of the tank motion. To eliminate this error a Type B weigher has been devised, in which at the moment of tipping but a small flow feeds the tank, the larger part of the total flow being previously deflected into the other tank by means of a simple float mechanism.
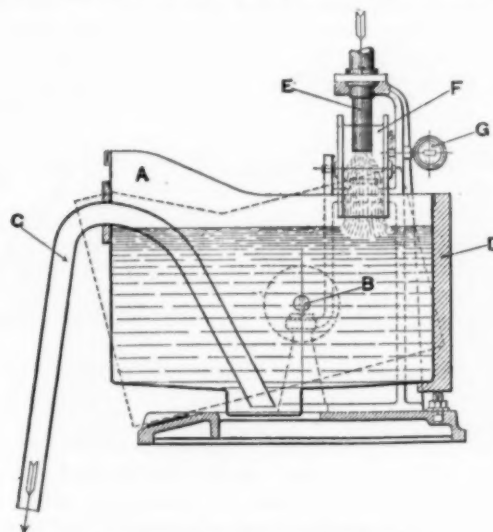
FIG. 3—SIDE SECTIONAL VIEW

In the latest improved type the deflector has been replaced by a circular valve. The machines are made in various sizes, ranging in capacity from 600 lb. per hour to 120,000 lb. per hour for ordinary liquids. It is claimed that an average accuracy of 0.5 per cent can be maintained by the Type A and Type C machines and that the Type B machine will register with an accuracy of 0.4 per cent regardless of changes in temperature or specific gravity of the liquid.

Work of the Bureau of Mines

From the annual report of the Secretary of the Interior we cull the following notes on the work of the Bureau of Mines, omitting the introductory notes on the purpose and chief features of work of the bureau, decrease of accidents in coal mines, rescue and first-aid work, improvement of health conditions in mines, and prevention of coal-mine explosions.

Fuel investigations.—In its efforts to increase efficiency in the use of mineral fuels the bureau is studying the properties of these fuels and the methods of burning them in furnaces and gas producers. Also it is collecting, analyzing, and testing samples of coal purchased under specifications for Government use. In the fiscal year 1916 the aggregate cost of the coal represented by these samples was $7,800,000. During the year the bureau continued to assist, in the capacity of a consulting fuel engineer, various departments and establishments of the Government in solving problems relating to the purchase of fuel and the efficient use of fuel for heating or power.

Problems of mineral technology.—The mineral technology investigations of the Bureau of Mines cover the minor metals, the rare and the precious metals, the metalloids and the nonmetals, brass and other nonferrous alloys, abrasives, cement, mineral products used as building materials, and many different minerals used in the arts.

In the United States 75,000 persons annually die of cancer, through the radium investigations of the bureau, in cooperation with the National Radium Institute, two great hospitals obtained during the year a

goodly supply of radium for the treatment of that disease. Low-grade radium-bearing ore, heretofore wasted, was concentrated successfully in a mill especially designed for the purpose. This concentrate, as well as high-grade carnotite ore, is being treated at the Bureau of Mines plant at Denver, which is now producing radium at the rate of 5 grams a year. The cost of production since operations began in June, 1914, has been less than $40,000 a gram, as compared with a market price of $100,000 to $120,000 a gram. This radium is not sold, but is to be used in the treatment of cancer.

Incidental to the production of radium at the Denver plant many tons of iron vanadate that can be used in the manufacture of high-grade vanadium steel and many tons of uranium oxide, used in coloring glass and making tool steel, have been produced. For an expenditure of less than $35,000 the Bureau of Mines will receive as its share of the results of the cooperative agreement at least $100,000 worth of radium.

In normal times the metal losses in brass melting in the United States annually amount to $3,000,000, and during the past year of high prices and large production have probably been nearer $10,000,000. As a result of its investigations of these losses the Bureau of Mines has devised an improved electric melting furnace which will be thoroughly tested on a commercial scale during the coming year. Also, because of the excessive loss of metal, sometimes running as high as 40 per cent. in melting scrap aluminum, the bureau has investigated methods of melting aluminum chips and is publishing the results.

In its clay-industry investigations the bureau has studied methods of so treating the secondary kaolins found in almost unlimited quantities in the Coastal Plain region of Georgia and the Carolinas as to render them applicable to the production of white wares. The results have demonstrated that these kaolins can be cheaply purified and that the purified material is superior to the best English china clay for making china, white crockery ware, and white tile.

Increasing efficiency and lessening waste in the petroleum and natural-gas industries.—Through its petroleum division the Bureau of Mines is investigating problems of technology, engineering, and chemistry in the production and utilization of oil and gas. The petroleum-technology investigations deal chiefly with practicable methods of eliminating waste in drilling wells and of recovering a larger proportion of the oil or gas stored in the productive sands; the engineering-technology investigations deal with storage, the prevention of losses from fires, and the manufacture of gasoline from natural gas; and the chemical-technology investigations deal with the mechanical development of the Rittman process for manufacturing gasoline, toluene, and benzene, and the improvement of methods for analyzing and testing petroleum and petroleum products.

Operators in different fields have been shown the need of properly protecting oil and gas sands from infiltrating water and of sealing wells so as to confine the natural gas securely until such time as it is utilized. Also, the bureau demonstrated the advantages of using mud fluid in drilling wells. Operators in Kansas and in the Blackwell field of Oklahoma are successfully using methods the bureau advocates. In the Blackwell field the operators should recover at least 80 per cent of the gas in the gas sands, whereas in older fields the recovery has been less than 10 per cent. A conservative estimate of the value of the gas that will be saved through the use of approved methods in the Blackwell field is $20,000,000.

The bureau is cooperating with the Bureau of Indian Affairs in the supervision of oil and gas operations on Indian lands.

Mechanical details of the Rittman process for making gasoline, benzene, and toluene were perfected during the year and the process was shown to be successful on a commercial scale. Tests have indicated how cheaply gasoline can be made from stove distillate.

Various gasolines sold in this country in 1915 were tested to determine their value as motor fuel. Other investigations included the production of gasoline from natural gas and the examination and analysis of petroleum.

Study of metallurgical problems.—In its metallurgical work the bureau continued to cooperate with the Selby and Anaconda smelter commissions, and during the year published as a bulletin the comprehensive report of the Selby Smelter Commission on alleged nuisance and damage occasioned by the Selby smelter in California. Especial attention is being given to the removal of sulphur from smelter gases. Cooperative work with the Anaconda Smelter Commission in the improvement of smoke conditions at the Anaconda smelter in Montana has led to the construction at the smelter of the first units of an electrical apparatus for treating smoke and to the operation of the first units of a sulphuric-acid plant that is to have a daily capacity of 140 tons of acid. Studies to effect the utilization of the acid in the manufacture of phosphates in Montana are in progress.

Under a cooperative agreement with the University of California the bureau has established a mining experiment station at Berkeley, Cal., where it is investigating problems relating to the smelting of lead and copper ores. Some of these problems are the absorption and purification of the sulphur dioxide in smelter smoke and the reduction of the gas to elemental sulphur by the wet Thiogen process. A study of the reduction of barium sulphate, a substance used in making paints and in various chemical industries, was completed.

Other work at Berkeley includes investigation of the improvement of the cyanide and other hydrometallurgical processes for treating ores of gold through the study of the efficiency of machines for crushing ores, the settling of slimes, and the behavior of aluminum in cyanide solutions.

Investigations at the Salt Lake City experiment station, conducted in cooperation with the University of Utah, deal chiefly with methods of preventing wastes in the concentration and metallurgical treatment of nonferrous ores, especially ores of lead and zinc, with the purpose of making available as ore the great bodies of material now considered waste. Encouraging results have been obtained in the treatment of lead ores by a chloridizing roast and leaching with a solution of common salt, in a volatilization process for treating oxidized ores of zinc, and in investigations of the flotation process for concentrating ores.

An investigation of hazards at blast furnaces in Pennsylvania was made in cooperation with the Pennsylvania Department of Labor and Industry. The dangers peculiar to work about Bessemer converters and open-hearth furnaces at steel plants have been investigated, and an investigation, in cooperation with the Federal Public Health Service, of health conditions in the steel and metallurgical plants of the Pittsburgh district was completed.

Comprehensive studies of the corrosion of metals in mines, with especial reference to damage to mining equipment and the corrosion-resisting qualities of various metals were continued through the year.

Investigation of the fluidity of blast-furnace slags, one purpose of which is to furnish metallurgists and

furnacemen with reliable data for use in smelting lean and complex ores, is being continued, and the results are being published. A new high-temperature viscosimeter has been developed by which the viscosity of slags can be accurately measured to a temperature of 2900 deg. F., or about 900 deg. higher than the highest temperature previously used in viscosity measurements of any substance.

In cooperation with the State School of Mines of Missouri, the bureau is continuing a study of the milling of lead and zinc ores in the Joplin district, Missouri, with particular reference to milling losses and the possibilities of treating the ores by flotation.

Chemical researches.—In addition to the chemical investigations already mentioned, the bureau studied the composition and properties of mine gases and natural gas. The investigations included an absorption method of extracting gasoline from natural gas which, if generally applied, will make possible the recovery of 100,-000,000 gal. of gasoline from natural gas each year; the errors that may arise in commercial methods of measuring natural gas at high pressure; the perfecting of a gas detector for use in mines and other places; methods of gas analysis; the chlorination of natural gas with a view to making tetrachloride, chloroform, and other valuable products; and the fusibility of coal ash as related to the formation of clinker in fuel beds.

Other investigations.—Special investigations that were described in reports published during the year or are still in progress include placer-mining methods, especially the use of gold dredges; iron-ore mining and iron making in the United States; utilization of low-grade fuel; gas-producer practice; and factors controlling the use and the market prices of fuel.

Personal

Mr. **J. W. Beckman**, consulting chemical engineer of the Great Western Power Co. and the Great Western Electrochemical Co. of San Francisco, Cal., and Mr. **H. E. Linden**, formerly associated with Stone & Webster, have formed the Beckman & Linden Engineering Corporation, with offices at 604 Balboa Building, San Francisco, and closely associated with it will be the Chemical Development Corporation. The object of this corporation will be primarily to develop uses and processes for the handling of many of the dormant resources available on the Pacific Coast.

Messrs. **Frederick G. Cottrell** and **Dorsey A. Lyon** of the United States Bureau of Mines were in Golden, Col., recently, conferring with R. B. Moore of the Colorado branch of the bureau and the authorities of the Colorado School of Mines relative to the co-operative investigations which are to be undertaken next year.

Mr. **J. V. N. Dorr** was recently a visitor in Denver in connection with business at the Denver office of the Dorr Company.

Mr. **R. S. Foster** has resigned his position as safety engineer at the Butte Mines of the Anaconda Copper Co. and has accepted a position with the Doe Run Lead Co. at Flat River, Mo., in a similar capacity.

Mr. **Geo. C. Hicks, Jr.,** vice-president and engineer of the P. H. and F. M. Roots Co. of Connersville, Ind., for the past fifteen years, announces his retirement from the company on Jan. 1, 1917. Mr. Hicks will act as consulting engineer for the company for a short time. Before taking up work again he expects to take a six months' vacation.

Mr. **R. H. Hodge**, formerly foundry expert of the Western Foundry & Machine Co., is now superin-tendent of the Ogden Iron Works, which is erecting a plant at Ogden, Utah. Mr. **George J. Silver,** formerly manager of the Western Foundry & Machine Co., will be consulting engineer.

Mr. **Dyke V. Keedy,** consulting and metallurgical engineer, of 6 Beacon Street, Boston, Mass., has gone to South America on professional business, to be gone some three months.

Mr. **K. L. Kithill,** head of the Arizona branch of the Bureau of Mines at Tucson, Ariz., has resigned his position with the government, and anticipates entering in business for himself at Denver.

Mr. **L. O. Koven** was the recipient on Dec. 21 of a sterling silver set consisting of six individual plates and tray, suitably inscribed, as a token of appreciation from the Eastern Supply Association, of which Mr. Koven was the president for the last three years.

Mr. **A. R. Levin** has been appointed New York manager for the Supplee-Biddle Hardware Company, Philadelphia, Pa., with offices at 30 Church Street.

Mr. **I. L. Merrill,** president of the Hedley Gold Mining Co., has left his home at Los Angeles, Cal., to inspect the company's properties at Hedley, B. C., Canada.

Mr. **C. E. Mills** has been elected as managing director for the Cananea Consolidated in Sonora, Mexico. Mr. Mills was the well known general manager of the Inspiration Consolidated, previous to the acceptance of his new position.

Mr. **Robert Schubert,** metallurgical engineer, sailed for Stavanger, Norway, on Dec. 28, to accept a position with the Stavanger Electro Staalwerk.

Mr. **Francis P. Sinn** of the New Jersey Zinc Co., Palmerton, Pa., has been elected a director of the National Safety Council. The council has a new section devoted to copper, lead and zinc smelting plants.

Mr. **Stanley M. Tracy,** until recently western district manager in the Chicago office of the Driver Harris Wire Co., is now assistant general sales manager at the main office and works of the company, Harrison, N. J.

Mr. **F. H. A. Wielgolashi,** a prominent engineer and nitrate expert from Norway, has recently come to Puget Sound in the interests of the American Nitrogen Products Company. He is now supervising the operation of the furnaces at the company's plant at La Grande, Wash., of which he is the inventor and will have direct charge of the plant for several months.

Mr. **T. K. Wilkinson** has returned to the Baltimore Copper Smelting & Rolling Company, Baltimore, Md., after an absence of two years.

CURRENT MARKET REPORTS
The Iron and Steel Market

The iron and steel market has continued dull by comparison with the intense activity that characterized the month of November. Strictly new buying has been light in both pig iron and finished steel, and there has been some decrease in specifications filed against finished steel contracts. Before the holidays the disposition to "go slow" was attributed almost exclusively to the suggestion that peace terms might be arranged for the European belligerents but the more mature reflection of the trade has led to the conclusion that nothing occurred that might not have been expected at almost any time. There was no occasion to assume that the war would never end, or to assume the impossible, that no peace overture would be made without several months' advance notice being given. The disposition now is to give more weight to the idea that the excited buying movement had to end soon by exhausting its force, and

the double influence of the peace overture and the holidays chanced to stop it rather suddenly.

There is no decrease whatever in the demand for material. It is simply in the making of additional engagements that a slowing down has occurred. Buyers are exerting as much pressure as ever upon mills to expedite their deliveries, and perhaps even more, as the partial breakdown of the transportation system of the country, under an unprecedented load, has slightly curtailed deliveries and occasioned fears that there would be a still more serious interruption to traffic.

It is only because the weather has been unseasonably mild that transportation has been maintained so well. A really cold snap would probably make more serious trouble than has yet been experienced. At Christmas time between twenty-five and thirty-five blast furnaces were banked on account of not receiving coke, chiefly from the Connellsville region, and many others were forced to slow down a trifle. At this writing nearly all the banked furnaces have resumed, partly on account of coke accumulating, but pig iron production is still distinctly less than the physical capacity. During the holidays there were considerable accumulations of finished steel at various works, partly by reason of car shortages and partly on account of embargoes. There have been frequent changes of rolling schedules on account of embargoes, and even those changes tend to cut down. At the moment very little steel is accumulating at mills but no progress to speak of has been made toward moving steel already accumulated. The industry is booked for serious times in the next two months and is much more concerned with production and transportation problems than with market problems.

PIG IRON

The pig iron market has been practically stationary as to prices. There is scarcely any inquiry for deliveries in the second half of the year, while there is a fair run of inquiry for earlier deliveries, ranging from spot to first half. In foundry and malleable grades premiums for quick delivery of small lots are usually obtained. Basic iron may be a shade easier than thirty days ago for second half delivery, but is correspondingly stiffer for early deliveries. There is an excellent run of export demand, but the governing factor is the vessel situation. If there were more vessel room much more export iron could be sold. Bessemer iron is quotable at $35 and basic iron at $30, f.o.b. valley furnaces.

UNFINISHED STEEL

There is an almost complete absence of offerings of unfinished steel in any form. Brokers and merchants are constantly scouring the trade but only occasionally find an odd lot. The mills do not quote for forward delivery at all. For soft steel in the form of billets, blooms, slabs, sheet bars, etc., export bids are generally at least $60, Pittsburgh or Youngstown, and sometimes run a little above that figure. Soft steel rods have brought $75.

FINISHED STEEL

Prices of finished steel are practically stationary. Last advances were $2 a ton in bars, plates and shapes, Dec. 20, as already reported, and $4 a ton in wrought iron and steel pipe, Dec. 30. There is no expectation of further changes in steel prices for some time to come, or until distinctly new developments occur. There is no basis upon which prices could well be advanced, for delivery at mill convenience, as there is not much inquiry for the late deliveries, and the turnover in prompt material is so light that no very definite market is established at any time. There is certainly nothing in prospect that would tend to depress prices, for the mills are more than comfortably filled with business for months and there is no incentive for any seller to cut prices.

Naturally, there is speculation as to what would occur were definite steps undertaken for the establishment of peace. By far the major part of the business on books of steel mills is for domestic consumption, of a character that would continue, peace or war. Buyers would expect an eventual readjustment in prices, but in the great majority of cases would not be in position to await the readjustment. While the view certainly has not been generally expressed, there is reason to doubt whether a continuance of the war, say for two years more, might not seriously decrease the demand for steel. The shipping situation is such that exports cannot be increased and the extremely high prices now current should tend eventually to alter the balance between domestic demand and production, seeing that production is increasing steadily except as interfered with by transportation conditions. It is more generally believed than formerly that the peace demand for steel, once prices have been readjusted, will be very large.

Non-Ferrous Metal Market

Monday, Jan. 8.—The markets in all the metals continue dull and both buyers and sellers have been holding off awaiting future developments. The statistics show 1916 to have been a most remarkable year both in production and value of product. Copper shows signs of developing some weakness, but this may only be temporary. Lead is strong and tin is steady. Spelter is unchanged in a dull market.

Copper.—Business in copper continues dull and consumers continue to be sellers along with producers and dealers. A feature of the market is the little interest shown in futures beyond March. Prices have declined for prompt delivery from 31.50 cents asked for both electrolytic and Lake on Dec. 28 to 28.25 cents for electrolytic and 29.00 cents for Lake on Jan. 5. The large producers are holding off and are holding their quotations on third and fourth quarter deliveries at 6.00 to 7.00 cents above the outside market. February delivery is quoted at 28.50 for Lake and 27.75 for electrolytic. First quarter electrolytic is held at 27.75, second quarter at 26.00 to 27.00, third quarter at 25.00 to 26.00, and fourth quarter at 24.00 to 25.00 in the outside market.

The copper statistics issued by the Geological Survey show an increase of 540,000,000 lbs. in smelter production in 1916 and an increase of 677,000,000 lbs. in refinery production. The refinery production is given as 2,311,000,000 lbs., and the smelter production as 1,928,000,000 lbs. The exports as given by the American Metal Market Report were 760,000,000 lbs., leaving 1,633,429,666 lbs. available for home consumption. How much of this was actually used is not known. A large demand for copper is expected from Germany after the war and Canada will probably want considerable shortly in view of her large munitions contracts, but whether domestic consumption will be large enough to take care of the balance not exported in 1917 will be a feature which will be watched with interest, as refinery capacity is being still further increased.

Tin.—The market has shown an improvement and on Jan. 1 Straits had advanced £3 10s. to £182 5s., with a similar advance in Standard. Our price for prompt delivery Straits jumped to 43.00 cents on Jan. 2, but has since eased off to 42.50 on little interest being shown by buyers. Deliveries in December, 1916, were 4082 tons, which are below normal. The total visible supply, including stocks afloat and on hand in all countries on Dec. 31 was 20,737 tons, or over 4000 tons

more than at the same time last year. The stocks in the United States were 3511 tons.

Lead.—Lead is unchanged and the market has continued dull but firm. The trust price is still on the basis of 7.50 cents New York with the outside price 7.50 to 7.62½. The production in 1916 was a new record of 579,600 tons. Exports are estimated at 108,200 short-tons lead produced from domestic ore, a gain of 21,000 tons over 1915. The domestic demand is large and partly explains the small amount for sale.

Spelter.—Spelter has remained quiet and practically unchanged, at 9.67½ to 9.92½ New York for prompt shipment. Futures are slightly lower on account of the small demand. February is quoted at 9.55 to 9.80, March at 9.42½ to 9.67½, and second quarter at 8.92½ to 9.17½. The production in 1916 was 658,-000 tons, or an increase of 34 per cent over 1915. Exports were 210,500 tons, or an increase of 59 per cent. Domestic consumption increased 22 per cent. The low prices prevailing at present are the result of production overtaking the demand.

Other Metals.—Antimony is unchanged at 14.25 to 14.50. Aluminum is unchanged at 60.00 to 64.00 cents for the No. 1 Virgin metal. Magnesium is unchanged at $3.50 per lb. Electrolytic nickel is 50.00 cents per pound; Cadmium $1.50; Cobalt $1.50 and quicksilver $90.00 per flask; tungsten ore is $17.50 to $20.00 per unit and silver 75⅜ cents.

Chemical Market

There has been a decided lull in practically all branches of the chemical trade during the past fortnight. The holidays interfered with prompt and nearby business to a marked degree and as a result of the peace negotiations, contracts have been invariably held up. Heavy chemicals that have been slowly but steadily advancing the past two or three months recorded marked declines at the first announcement of the possibility of peace and have not recovered. There is a probability that higher prices will be reached for deliveries in nearby positions with contract business holding fire until the peace question is definitely decided.

As a result of this condition and the likelihood of munition contracts halting, glycerin has been subject to a rather sharp decline. . For C. P. and dynamite business has passed as low as 53c. although the general asking price is 1c. to 2c. higher. The C. P. and dynamite grades are quoted on about the same level at the moment.

Potassium cyanide is now practically off the local market. The sodium and the mixture are being traded in to some extent with the former quoted at about $1.75 to $1.85 spot and the mixture at $2.05. Future shipments from Japan are offered at lower figure, sodium cyanide for example, at $1.20. But small amounts of Japanese material are en route so that the spot market is not affected.

Soda ash, caustic soda, bichromates of soda and potash and bleaching powder have not recovered from the decline recorded coincident with the announcement of peace negotiations and contract business has been almost entirely suspended.

Despite an enormous production, sulphuric acid is selling at a somewhat higher level. Important Pennsylvania producers are asking $30 for 66 degree brimstone f.o.b. Some business of this description has passed at $28 however. The production of acid in the United States last year was enormous. In the absence of positive figures it is possible to arrive at a fairly accurate estimate. The imports of pyrites totaled 1,-500,000 tons. The total consumption was possibly 2,-300,000 tons. On the basis of 50 per cent sulphur content of this ore and a theoretical recovery of 2.35 tons of acid from each ton of pyrites consumed, the production of pyrites acid would have been approximately 5,400,000 tons of 50 deg. Baume acid. This figure does not include the acid production from brimstone, statistics of which are not available. The brimstone acid production in 1916 was the heaviest on record. The actual production of both brimstone and pyrites acids in 1915 was 3,868,152 tons.

Other mineral acids have not been subject to much change. Nitric acid, so important with munition manufacturers, has remained stationary, but the feeling was an easier one. Muriatic acid business continues spasmodic.

In the coal tar classification, there have been freer offerings of aniline oil, dinitrophenol and phenol. The aniline oil market appears to be suffering more from keen competition than from an over-production, as there are hardly more than fifteen active producers at the moment. As a result of new manufacturers entering the field, offerings of dinitrophenol are more abundant and prices are easier. As a result of a refusal of one large consumer to accept contract deliveries, surplus stocks reached the open market and prices were easier. This condition is temporary, however. Most phenol producers are well sold out.

Benzol is somewhat firmer. The leading producers have advanced prices somewhat. The production is well covered by contract. Toluol for delivery next year is particularly scarce and large manufacturers advise that the only stocks that will be available will be surplus stocks over their contracts.

Alcohol business has been quite large and the market has held up well in view of the heavy business. Production is proceeding upon a record scale.

Arsenic has advanced with stocks light. All producers have marked up selling prices. This is, perhaps, incidental to the season as manufacturers of paris green and spraying solutions are preparing for an active spring season.

Sulphate of copper has been subject to practically no change during the fortnight. Firmness expected has not materialized as the export business absorbed a great bulk of this production and the peace negotiations have, of course, suspended important business for foreign account.

Sulphate of ammonia, except for resale lots, is practically out of the market. Producers are sold, as a rule, six months ahead. The 1916 production of ammonia reduced to the sulphate equivalent is figured as 325,000 tons, an increase of 113,000 tons over 1915.

General Chemicals

Acetone, Drums	lb.	.22½ —	.24
Acid, acetic, 28 per cent	100 lb.	3.25 —	3.75
Acetic, 56 per cent	100 lb.	8.00 —	8.25
Acetic, glacial, 99½ per cent, carboys	lb.	.32 —	.35
Boric, crystals	lb.	.13 —	.13½
Citric, crystals	lb.	.64 —	.66
Hydrochloric, commercial, 18 deg	lb.	.01½ —	.01¾
Hydrochloric, 20 deg	lb.	.01¾ —	.02
Hydrochloric, C. P., conc., 22 deg	lb.	.02 —	.02½
Hydrofluoric, 30 per cent, in barrels	lb.	.04½ —	.05½
Lactic, 44 per cent, light	lb.	.13½ —	.14½
Lactic, 22 per cent	lb.	.06½ —	.07
Nitric, 36 deg	lb.	.04¾ —	.05
Nitric, 42 deg	lb.	.05¼ —	.06
Oxalic, crystals	lb.	.44 —	.45
Phosphoric, 85 per cent	lb.	.30 —	.32
Picric	lb.	.60 —	.75
Pyrogallic, resublimed	lb.	3.10 —	3.25
Sulphuric, 60 deg	ton	20.00 —	21.00
Sulphuric, 66 deg	ton	27.00 —	30.00
Sulphuric, oleum (Fuming), tank cars	ton	38.00 —	40.00
Tannic, U. S. P. bulk	lb.	.88 —	.92
Tartaric, crystals	lb.	.66 —	.67
Alcohol, grain, 188 proof	gal.	2.68 —	2.70
Alcohol, Wood, 95 per cent	gal.	.88 —	.90
Alcohol, Denatured, 180 proof	gal.	.65 —	.66
Alum, ammonia lump	lb.	.04 —	.04¼
Alum, chrome	lb.	.21 —	.22
Alum, potash lump	lb.	.05 —	.06

Aluminum sulphate, technical	lb.	.01⅗—	.02⅕
Aluminum sulphate, iron ·ree	lb.	.03½—	.04
Ammonia aqua, 26 deg. carboys	lb.	.05½—	.05¾
Ammonia, anhydrous	lb.	.24 —	.28
Ammonium carbonate	lb.	.12½—	.13
Ammonium nitrate	lb.	.13¼—	.14
Ammonium sulphate, domestic	lb.	.04½—	.04½
Amyl acetate	gal.	4.25 —	4.50
Arsenic, white	lb.	.08¾—	.09½
Arsenic, red	lb.	.65 —	.70
Barium chloride	ton	90.00 —	95.00
Barium sulphate (Blanc Fixe) powder	lb.	.04 —	.04½
Barium nitrate	lb.	.11 —	.12
Barium peroxide	lb.	.40 —	.50
Bleaching powder, 35 per cent	lb.	.0415—	.0420
Borax, crystals, sacks	lb.	.07¾—	.08
Brimstone, crude	ton	28.00 —	29.00
Bromine, technical	lb.	1.20 —	1.30
Calcium acetate, crude	lb.	.03¼—	.03½
Calcium carbide	ton	68.00 —	75.00
Calcium chloride, 70-75 per cent, fused, lump	ton	21.50 —	22.00
Calcium peroxide	lb.		
Calcium sulphate	lb		
Caclium phosphate	lb.		
Carbon bisulphide	lb.		
Carbon tetrachloride, drums	lb.	.05½—	.06
Caustic potash 88-92 per cent	lb.	.15¾—	.16
Caustic soda, 76 per cent	lb.	.84 —	.86
Chlorine, liquid	lb.	.01½—	.01¾
Copperas	100 lb.	1.10 —	1.25
Copper carbonate	lb.	.35 —	.37
Copper cyanide	lb.	.70 —	
Copper sulphate 99 per cent large crystals	lb.	.12¼—	.12½
Cream of tartar, crystals	lb.	.38 —	.40
Epsom salt bags	100 lb.	1.65 —	1.80
Formaldehyde, 40 per cent	lb.	.11½—	.12
Glauber's salt	100 lb.	.75 —	.80
Glycerine, bulk c. p.	lb.	.53 —	.54
Hydrogen peroxide, gross		6.50 —	12.00
Iodine, resublimed	lb.	4.00 —	4.25
Iron oxide	lb.	.02½—	.10
Iron sulphide	lb.	.03¾—	.04¼
Lead acetate, white crystals	lb.	.13 —	.13½
Lead arsenate	lb.	.08½—	.08½
Lead nitrate	lb.	.15½—	.16
Litharge, American	lb.	.08½—	.09
Lithium carbonate	lb.	1.00 —	1.05
Manganese dioxide	lb.	.66 —	.70
Magnesium carbonate, tech	lb.	.13½—	.15
Nickel salt, single	lb.	.14 —	
Nickel salt, double	lb.	.11½—	
Phosporus, red	lb.		
Phosphorus, yellow	lb.	1.00 —	1.10
Potassium bichromate	lb.	.85 —	.90
Potassium bromide granular	lb	.40 —	.41
Potassium carbonate calcined, 80-85 per cent	lb.	1.30 —	1.35
Potassium chlorate, crystals	lb.	.34 —	.36
Potassium cyanide, 98-99 per cent	lb.	.64 —	.65
Potassium iodide	lb.	2.35 —	2.50
Potassium muriate, 80-85 p. c., basis of 80 p. c.	lb·	3.45 —	3.50
Potassium nitrate	ton	435.00 —	450.00
Potassium permanganate	lb.	.27 —	.30
Potassium prussiate, red	lb.	2.65 —	3.00
Potassium prussiate, yellow	lb	2.35 —	2.50
Potassium sulphate, 90-95 p. c., basis 90 p. c.	lb.	.91 —	.93
Rochelle salts	ton	265.00 —	275.00
Sal ammoniac, gray, gran	lb.	.33 —	.34
Sal ammoniac, white, gran	lb.	.11 —	.14
Sal soda	100 lb.	.17¼—	.18
Salt cake	100 lb.	1.00 —	1.10
Silver cyanide		.65 —	.75
Silver nitrate	oz.	.70 —	.71
Soda ash, 58 per cent, light, flat	lb.	.46¾—	
Soda ash, 58 per cent, dense, flat	lb.	.0290—	0.295
Sodium acetate	lb.	.0340—	0.350
Sodium benzoate	lb.	.12 —	.13
Sodium bicarbonate, domestic	100 lb.	8.00 —	8.50
Sodium bicarbonate, English	lb.	1.60 —	1.70
Sodium bichromate	lb.	.02⅞—	.03
Sodium bisulphite, powd	lb.	.17 —	.17½
Sodium chlorate	lb.	.05 —	.05½
Sodium cyanide	lb.	.25 —	.26
Sodium fluoride, commercial	lb.	1.80 —	1.90
Sodium hyposulphite	lb.		
Sodium nitrate, refined	lb.	.01¼—	.01½
Sodium nitrite	100 lb.	3.27½—	3.32½
Sodium peroxide	lb.	3.25 —	3.30
Sodium phosphate	lb.	1.10 —	1.20
Sodium prussiate yellow	lb.	.04½—	.05
Sodium silicate, liquid	lb.	.31 —	.32
Sodium sulphide, 30 per cent crystals	100 lb.	.80 —	.85
Sodium sulphite	lb.	.02⅛—	.02¼
Strontium nitrate	lb.	.12 —	.12½
Sulphur chloride, drums	lb.	.40 —	.50
Sulphur, flowers, sublimed	lb.	.09½—	
Sulphur, roll	100 lb.	2 30 —	2.32
Sulphur, crude	100 lb.	1.95 —	2.00
Tin bichloride, 50 deg	ton	35.00 —	
Tin oxide	lb.	.13½—	.13⅝
Zinc carbonate	lb.	.46 —	.47
Zinc chloride	lb.	.24 —	.25
Zinc cyanide	lb.	.13 —	.15
Zinc dust	lb.	.50 —	
Zinc oxide, American process XX	lb.	.22 —	.26
Zinc sulphate	lb.	.10¾—	.11¼
	lb.	.06½—	.06¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.57 —	.60
Benzol, 90 per cent	gal.	.55 —	.60
To'uol, pure, water white	gal.	1.70 —	1.90
Xylol, pure, water white	gal.	1.00 —	1.20
Solvent naphtha, water white	gal.	.24 —	.28
Solvent naphtha, crude heavy	gal.	.15 —	.20
Creosote oil 25 per cent	gal.	.27½—	.32
Dip oil 20 per cent	gal.	.25 —	.26
Pitch, various grades	ton	12.00 —	14.00
Carbolic acid, crude, 95 to 97 per cent	lb.	.80 —	.85
Carbolic acid, crude, 50 per cent	lb.	.60 —	.65
Carbolic acid, crude, 25 per cent	lb.	.28 —	.30
Cresol, U. S. P.	lb.	.18 —	.20
Cresylic acid, refined No. 5	lb	.19 —	.22

Intermediates, Etc.

Alpha naphtylam ne	lb.	1.00 —	1.25
Aniline oil	lb.	.21¾—	.22½
Aniline salts	lb.	.28 —	.30
Anthracene, 80 per cent	lb.	.10 —	
Benzaldehyde	lb.	4.75 —	5.00
Benzidine Base	lb.	1.80 —	1.90
Benzidine, Sulphate	..	1.50 —	1.65
Benzoic acid	lb.	8.50 —	9.00
Beta naphthol Sublimed	lb.	.90 —	.95
Dichlor benzol			
Dimethylaniline	lb.	.55 —	.57
Diphenylamine	lb.	.80 —	.85
H-acid	lb.	2.15 —	2.25
Metaphenylenediamine	lb.	1.50 —	1.75
Monochlorbenzol		.30 —	.32
Naphthalene Flake	lb.	.09½—	.10
Naphthionic acid, refined	lb.	2.00 —	2.10
Naphthionic acid, crude	lb.	1.00 —	1.05
Ortho-amidophenol			
Ortho-toluidine			
Para-amidophenol	lb.	1.50 —	1.60
Paranitraniline	lb.	4.50 —	6.00
Paraphenylenediamine	lb.	1.60 —	1.75
Para toluidine	lb.	3.50 —	3.75
Paenol, U. S. P.	lb.	2.00 —	2.10
Resorcin, technical	lb.	.51 —	.53
Resorcin, pure	lb.	8.75 —	9.50
Salicylic acid	lb.	20.00 —	22.00
Salol	lb.	1.00 —	1.10
Sulphanilic acid	lb.	2.25 —	2.30
Toluidine-mixture	lb.	.40 —	.45
	lb.	1.00 —	1.10

Petroleum Oils

CRUDE (AT THE WELLS)

Pennsylvania	bbl.	2.95 —	..
Corning, Ohio	bbl.	2.20 —	..
Somerset, Ky.	bbl.	2.10 —	..
Wooster, Ohio	bbl.	1.90 —	..
Indiana	bbl.	1.53 —	..
Illinois	bbl.	1.72 —	..
Oklahoma and Kansas	bbl.	1.60 —	..
Caddo, La., light	bbl.	1.50 —	..
Corsicanna, Tex., light	bbl.	1.20 —	..
California	bbl.	.74 —	..

LUBRICANTS

Black, reduced, .29 gravity, 25-30 cold test	gal.	.13½—	.14
Cylinder, light		.21 —	.26
Cylinder, dark		.18 —	.19
Extra cold test		.26 —	.31
Paraffine, high viscosity		.29½—	.30
Paraffine, .903 spec. gr.		.21½—	.22
Paraffine, .865 sp. gr.		.18½—	.19

Flotation Oils

Pine oil, steam distilled	gal.	.58 —	..
Pine oil, destructively distilled	gal.	.46 —	..
Pine-tar oil	gal.	.19 —	..
Pine-tar oil, double refined	gal.	.27 —	..
Pin oil, light	gal.	.37 —	..
Pine oil, heavy	gal.	.26 —	..
Pine tar, thin	gal.	.18 —	..
Turpentine, crude	gal.	.38 —	..
Hardwood oil, f.o.b. Michigan	gal.	.16 —	..
Creosote, coal tar, neutral	gal.	.15½—	..
Creosote, coal tar, acid	gal.	.21½—	..
Coal tar, thin	gal.	.11 —	

Vegetable and Other Oils

China wood oil	gal.	.12 —	.12¾
Cottonseed oil, crude	gal.	.81 —	.82
Linseed oil, raw	gal.	.92 —	..
Peanut oil, crude	gal.	.85 —	.86
Rosin, 280 lb.	bbl.	6.55 —	..
Rosin oil, first run	gal.	.38 —	..
Soya bean oil, Manchuria	gal.	.12 —	.12¼
Sperm oil, bleached winter, 38 deg.	gal.	1.03 —	1.05
Turpentine, spirits	gal.	.55 —	.56

Miscellaneous Materials

Barytes, floated, white	ton	25.00 —	35.00
Beeswax, white, pure	lb.	.45 —	.50
Carnauba wax, highest grade	lb.	.50 —	.52
Chalk, light, precipitated, English	lb.	.04½—	.05½
Feldspar	ton	8.00 —	12.00
Fuller's earth, powdered	100 lb.	.80 —	1.05
Plaster of Paris	bbl.	1.50 —	1.70
Red lead, dry, carloads	lb.	..	.09¾
Soapstone	ton	10.00 —	12.50
Talc, American, white	ton	10.00 —	13.00
White lead, dry	lb.	..	08.¾

Refractories, Etc.

(F.O.B. WORKS)

Chrome brick	net ton	120.00 —	130.00
Chrome cement, Grecian	net ton	80.00 —	90.00
Clay brick, 1st quality fireclay	per 1000	40.00 —	50.00
Magnesite, Grecian, dead burned	net ton	85.00 —	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00 —	140.00
Silica brick	per 1000	40.00 —	45.00

Ferroalloys

Ferro-carbon-titanium, carloads	lb.	.08 —	
Ferrochromium		Nominal	
Ferromanganese, domestic, delivered		175.00	..
Ferromanganese, English	ton	165.00 —	..
Ferromolybdenum	lb.	4.00 —	..
Ferrosilicon, 50 p. c., carloads, del. Pittsburgh	ton	100.00 —	..
Ferrotungsten, 75-85 p. c., f.o.b. Pittsburgh	lb.	2.30 —	..
Ferrovanadium, f.o.b. works	lb.	2.75 —	3.00

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

Alliance Brass Foundry Co., Detroit, Mich., has been incorporated with a capital of $50,000 to deal in machines. Incorporators are A. Manche, E. M. Sloman, D. W. Berry.

Alunite Corporation, Wilmington, Del., has been incorporated with a capital of $20,000 to mine gold and silver.

American Explosives Co., St. Louis, Mo., has been incorporated with a capital of $50,000. Incorporators are E. B. McAbee, E. Cole and J. H. Robb. Manufacture and deal in explosives.

American Fuel Company, Atlantic City, N. J., has been incorporated with a capital of $500,000.

American Magnesium Corp., Niagara Falls, N. Y., has been incorporated with a capital of $300,000 to manufacture and deal in magnesium, calcium, metals, coal, coke, etc. Incorporators are J. J. Devereaux, J. Hallenbeck, E. W. Burdick, 445 West 153d Street, New York.

Armour & Co., the Chicago packers, has purchased four of the largest tanneries in the Punxsutawney, Pa., district, viz.: The Big Run Tannery, the Gleasontown Tannery, the Driftwood Tannery, and the Medix Run Tannery. The amount involved is believed to be about $4,000,000.

Aroostook Pulp & Paper Co., Inc., Boston, Mass., has been incorporated with a capital of $500,000. Incorporators are A. B. Blandin, G. S. Lewis, S. F. Johnson, H. Ketchum, E. T. Connolly, E. P. Lindsay.

Atlantic Potash Co., Inc., Eddyville, N. Y., has been incorporated with a capital of $177,500 to deal in chemicals. Incorporators are S. B. Howard, S. A. Anderson, A. W. Britton, 65 Cedar Street, New York.

Bardeen Paper Co., Otsego, Mich., has increased its capital from $175,000 to $1,000,000.

The Benzol Products Company has increased its capital from $1,000,000 to $1,500,000.

Bowditch Dye Works, Inc., Boston, Mass., has been incorporated with a capital of $10,000 to deal in cotton, wool, rags, dyes, etc. Incorporators are G. A. Vaughn, Dexter Elliott, B. Linesey, Jr., F. Ashton.

Bridgeport Iron & Metal Co., Bridgeport, Conn., has been incorporated with a capital of $50,000. Incorporators are W. Alderman, Ansonia; P. Nowitz, Bridgeport; A. Alderman, Ansonia.

Bristol Power, Pulp & Paper Co. has been incorporated in Delaware with a capital of $1,000,000 to deal in wood, paper, etc. Incorporators are M. Dougherty, M. C. Donohue, F. Giles, all of Wilmington.

Burd-Beidler Metals Corp., New York, has been incorporated with a capital of $1,500,000 to manufacture hardware, mechanical appliances, jewelry and novelties. Incorporators are L. Burd, W. A. Leonard and W. F. Lynch, of New York City.

Burdett Gas Service Corporation, Wilmington, Del., has been incorporated with a capital of $3,000,000 to manufacture gas oxygen and any article in which gas is used.

California Fiber & Pulp Co., Los Angeles, Cal., has been incorporated with a capital of $50,000. Incorporators are A. J. Harno, E. C. Steggall, E. W. Bothwck, R. B. Turnbull, J. B. Meikle.

The Carbon Block Mining Co., Cincinnati, Ohio, has been incorporated with a capital of $25,000. Incorporators, G. Rapp, and others.

The Carso Paper Co., Dansville, N. Y., has been incorporated with a capital of $100,000. Incorporators are J. R. Carter, J. A. Ault, H. T. Kehew, L. C. Anderson, W. R Carter, E A. Carter.

Carson Hill Consolidated Gold Mines, Portland, Me., has been incorporated with a capital of $300,000 to mine, mill, smelt and prepare all kinds of metals and ores, etc., for market.

Cayuga Tool Steel Co., Auburn, N. Y., has been incorporated with a capital of $200,000 to manufacture furnaces, mills, iron and steel. Incorporators are A. B. King, J. H. Richards, H. D. Canaday, 2114 Canton Avenue, Brooklyn, N. Y.

Central Creosoting Co., Winneta, Ill., has been incorporated with a capital of $200,000 to engage in general creosoting business. Incorporators are P. Kimier, R. Swanson, E. S. Burling, H. Wood.

The Central Sugar Corp., Albany, N. Y., has been incorporated with a capital of $3,400,000 to conduct a sugar plantation and refinery and raise sugar. Incorporators are H. P. Dubois, F. S. Connett, F. J. Bomm, of New York City.

Chemical Pigment Co., Baltimore, Md., has been incorporated with a capital of $265,000 to manufacture pigment and chemical products.

Chemical Products Corp., Camden, N. J., has been incorporated with a capital of $200,000 to deal in chemicals. Incorporators are F. R. Hansell, J. A. MacPeak, I. C. Clow.

The C. H. Clark Oil Co., Cleveland, Ohio, has been incorporated with a capital of $20,000 to deal in paints. Incorporators are I. T. Quick, J. M. Cantillon, C. H. Clark, I. M. Clark, A. R. Lawrence.

The Cleveland Foundry Co., the Cleveland Metal Products Co., and the Cleveland Factory Co. have announced to stockholders a plan of consolidation into a $10,000,000 company to be known as the Cleveland Metal Products Co. The Cleveland Foundry Co. produces oil stoves, the Cleveland Metal Products Co., sheet aluminum and utensils, and the other company is a realty holding concern.

Commercial Acid Co., E. St. Louis, Mo., has been incorporated with a capital of $150,000. The company was organized by W. H. Cocke, J. W. Garhard and G. M. Byrns to manufacture and sell chemicals.

Concord Mining Co., Webb City, Mo., has been incorporated with a capital of $100,000 to conduct a general mining business. Incorporators are C. E. Crane, F. S. Gardiner, P. Gray.

Consumers' Explosives Co., Augusta, Me., has been incorporated with a capital of $750,000 to manufacture explosives. Incorporators are E. M. Leavitt, E. L. McLean.

The Dellerbrook Chemical Co., Lima, Ohio, has been incorporated with a capital of $50,000. Incorporator, E. R. Dellerbrook.

Dento Chemical Co., Dover, Del., has been incorporated with a capital of $500,000 to carry on the business of chemists and druggists.

The Detroit Copper & Brass Rolling Mills, Detroit, Mich., has been incorporated with a capital of $3,000,000.

Duall Leather Corp., New York, has been incorporated with a capital of $630,000 to manufacture and deal in leather, textile fabrics. Incorporators are A. G. Quinn, C. A. Meier, W. McCarroll, 152 Broadway.

The Federal Dyestuff and Chemical Corporation, Kingsport, Tenn., has increased its capital from $1,500,000 to $2,000,000.

Goodwater Graphite Co., Inc., Philadelphia, Pa., has been incorporated with a capital of $550,000 to manufacture graphite, iron and steel. Incorporators are W. L. Shumate, Jr., Birmingham, Ala.; Eugene Argo, and T. D. Eppes, Goodwater, Ala.

The Grand Rapids Grinding Co., Grand Rapids, Mich., has been incorporated with a capital of $25,000 for manufacturing and selling machinery and metal goods. Incorporators are S. Owen, Livingston C. F. Hext, J. DeKoning.

Hattiesburg Pulp & Board Co., Portland, Me., has been incorporated with a capital of $1,250,000 to manufacture pulp and paper.

Holland Aniline Co., Holland, Mich., has been incorporated with a capital of $250,000 to manufacture and deal in aniline dyes and chemicals. Incorporators are Frans Franklin and V. C. Mape, of Holland, and L. Weisbery, of Chicago.

Hood Foundry Co., Wilmington, Del., has been incorporated with a capital of $50,000 to manufacture iron castings, steel castings, etc.

Ideal Piece Goods Dyeing Co., Paterson, N. J., has been incorporated with a capital of $100,000 to operate factory for dyeing dress goods and textile fabrics. Incorporators are C. M. Riva, J. D. Huyvetters, J. Davison.

Imperial Dye Wood Co., Inc., Hackensack, N. J., has been incorporated with a capital of $125,000 to deal in dyewoods. Incorporators are A. C. Hart, V. A. Hart, Hackensack; J. S. Baker, Garfield.

Independent Mines Smelting Co., Inc., Wilmington, Del., has been incorporated with a capital of $1,500,000 to operate the Ward-Abel Parabola Oil Burning Smelter and other devices.

The Lima Metals Foundry Co., Lima, has been incorporated with a capital of $15,000. Incorporators are M. G. Bush, S. Wiesenthal, John Thomas.

The Loomis-Sielaff Co., Cleveland, Ohio, has been incorporated with a capital of $150,000 to manufacture and deal in metal products. Incorporators are J. G. Fose, M. M. Feidner, H. E. Davis, W. G. Radcliffe, R. E. Kouba.

McKesson & Robbins, Inc., Milbrook, N. Y., has been incorporated with a capital of $2,000,000 to manufacture and deal in chemicals, etc. Incorporators are G. C. and J. McKesson, H. D. Robbins, 91 Fulton Street, New York.

Midland Carbon Co., Wilmington, Del., has been incorporated with a capital of $500,000 to deal in carbon black products.

Henry-Miller Foundry Company, Cleveland, Ohio, has been incorporated with a capital of $1,000,000. Incorporator, T. E. Henry.

Montague Gold Mining Co., New York, has been incorporated with a capital of $1,000,000 to engage in mining of gold, silver, lead, copper and other ores. Incorporators are F. E. Reese, T. J. Buckley, J. Lecour, Jr., all of New York.

Moore Paper Mill Corp., Buffalo, N. Y., has been incorporated with a capital of $50,000 to manufacture paper and box board. Incorporators are W. P. Goodsneed, B. S. and C. G. Moore, 207 Anderson Place, Buffalo.

The National Process Co., Cleveland, Ohio, has been incorporated with a capital of $10,000 to deal in paints. Incorporators are C. Taussig, H. K. Fox, E. H. Blywise, A. M. Wilber and M. Skala.

Neosho Zinc Co., New Haven, Conn., has been incorporated with a capital of $150,000. Incorporators are A. M. Brown, W. A. Wright, G. M. Bliger.

The Northwestern Leather Co., Boston, Mass., has been incorporated with a capital of $1,500,000.

Odorless Fertilizer Mfg. Co., Wilmington, Del., has been incorporated with a capital of $250,000 to manufacture fertilizers.

O-Zel-O Company, Fort Wayne, Ind., has been incorporated with a capital of $15,000 to manufacture chemicals. Incorporators are J. Miller, H. W. Muller, H. C. Barnes.

The Pennsylvania Rubber Co., Jeanette, Pa., has been incorporated with a capital of $2,000,000.

Rosslyn Steel & Cement Co., Washington, D. C., has been incorporated with a capital of $15,000. Incorporators are C. T. Kingsbury, C. E. Dale, W. T. Galliher, B. C. Downey, F. L. Wagner, A. A. Hoehling

Rubber Patchit Corp., Manhattan, has been incorporated with a capital of $80,000 to manufacture rubber and leather products and vulcanizing materials. Incorporators are F. Rogers, E. Goldfalb, C. Bogardus, 140 Nassau Street, New York City.

Seneca Copper Corp., New York, has been incorporated with a capital of $1,000,000 to mine, mill and smelt gold, silver, copper, lead, etc. Incorporators are K. A. Duffy, S. Kramer, F. G. Fischer, 15 Broad Street.

The Shaeffer Oil Corporation, Wilmington, Del., is incorporated with a capital of $50,000.

Sivalls & Brysons, Inc., Portland, Me., has been incorporated with a capital of $600,000 to manufacture and deal in oil tanks, water tanks, and gas tanks, to acquire oil and gas lands, etc.

South American Electric Smelting Co., New York, has been incorporated with a capital of $50,000. Incorporators are J. B. Pruyn, C. W. Whittlesey, W. P. Martin, 17 Battery Place.

South Florida Sugar Co., Miami, Fla., has been incorporated with a capital of $50,000 to refine sugar.

Southern Oil Co., Bettyville, N. Y., has been incorporated with a capital of $40,000. Incorporators are C. Beach, R. G. Porter, W. Porter, L. Thomas, T. Blakey.

The Stanley Aniline Chemical Works, of Lockhaven, Pa., has increased its capital stock from $1,000,000 to $2,000,000.

Superior Steel Corporation, Richmond, Va., has been incorporated with a capital of $17,000,000. Incorporators are M. Rogers, president; W. J. Schaefer, treasurer; A. J. Christian, secretary.

Thunderbolt Copper Co. has been incorporated in Delaware with a capital of $2,-000,000 to conduct a general mining business. Incorporators are C. A. Cole, Hackensack, N. J.; Robert A. Van Voorhis, Jersey City; A. R. Oakley, Pearl River, N. Y.

Universal Leather Co., Trenton, N. J., has been incorporated with a capital of $50,000 to manufacture leather goods. Incorporators are W. F. Gips, S. P. Friedman, New York; C. K. Kuttner, M. E. Ruback, Newark.

Utah-Idaho Sugar Co., Salt Lake City, Utah, has been incorporated with a capital of $10,000,000. Incorportors are Joseph, Smith and Horace G. Whitney.

Utilities Co., Inc., Ringling, Okla., has been incorporated with a capital of $1,000,-000 that is to establish natural gas and electric plants and develop water power sites in southern Oklahoma. Incorporators are P. C. Ekern, C. Dings, W. D. Potter.

The Whitfield Iron Co., Cleveland, Ohio, has been incorporated with a capital of $10,-000. Incorporators ars F. S. McGowan, A. R. Manning, Jr., S. Chestnutt, J. M. Harris, J. K. Lee.

Construction and Operation

Arizona

JEROME.—The United Verde Extension plans the erection of a large smelter on the C. V. Hopkins branch, near Cottonwood. A. G. McGregor, well known metallurgist, will superintend the construction. He recently visited Jerome with President James S. Douglas of the Extension Company to investigate the possibilities, and it is understood that work will be pushed as fast as possible on the new plant.

TUCSON.—Reported Mineral Hill Mining Co. plans erecting smelter and concentrating plant. Frederick Minard, engr., 111 Broadway, New York City.

California

LOS ANGELES.—The C. W. Hill Chemical Company has purchased a large site on San Pedro Street, between Sixth and Seventh Streets, on which a new plant will be erected.

MANTECA.—The contract has been awarded by the Spreckles Sugar Company to the Dyers Construction Company, of Cincinnati, Ohio, for the $2,000,000 sugar plant which they will erect at Manteca. The same construction company is building a $1,000,000 refinery for the Whitehall estates near Tracy.

NEWPORT.—It is expected that the Newport Glass Company, Inc., will shortly operate its factory here, as machinery and equipment are being installed.

OAKLAND.—The East Bay Foundry will erect a $50,000 plant at Thirty-second and Chestnut Streets. The company will manufacture cast iron to be used in shipbuilding.

RIVERSIDE.—The Sterns-Roger Manufacturing Company of Denver, which has established several sugar mills in Colorado and Utah, has offered to establish a million-dollar plant in Riverside if 10,000 acres of beets can be signed up. The Riverside and Arlington Chambers of Commerce are working for the plant.

SAN FRANCISCO.—The National Carbon Company has applied for a permit to erect a four-story and basement brick mill and factory building at the northeast corner of Brannan and Eighth Streets, which will cost $220,000.

SAN FRANCISCO.—The Pacific Tank & Pipe Company announces the completion of the first of the buildings of its new plant located on a 95-acre tract near the Melrose Station of the Southern Pacific on San Francisco Bay. The plant at present comprises four main buildings from 200 to 260 ft. long and 100 ft. wide. The main office of the company is at 316 Market Street, San Francisco. The officers of the company are E. C. Pitcher, president and general manager; R. R. Streets, vice-president; George T. Gerkin, chief engineer, and F. W. Schmitz, sales manager.

SAN FRANCISCO.—Plans were considered for the construction and operation of a co-operative paper mill at the meeting of The California Press Association in De-

cember. It was pointed out that at $7 a hundred for newsprint in ton lots and $6 a hundred in carload lots, it will soon be difficult for the small country paper to continue.

SAN PEDRO.—The Union Oil Company has purchased 231 acres on the McDonald ranch, between Wilmington and San Pedro, for a consideration said to be $275,000. A new $2,500,000 refinery will be erected on this site. The land purchased is some of the most valuable in the harbor district. It overlooks the West Basin tidelands and lies between the Wilmington Road and the Gardena line of the Pacific Electric. The plans of the company are said to include a new subdivision for homes of employees at the refinery.

VALLEJO.—The Universal Chemical Company, organized by Jas. J. Hagan and others, has purchased a site for a manufacturing plant. Various chemical compounds are to be produced in the new plant, the first of which will be an oil emulsion for destroying pests that damage fruit trees.

Connecticut

STAMFORD.—The Stamford Rolling Mills Company is finishing its last war contract in the Springdale plant. All work of this nature has been finished at the Fairfield Avenue plant, and there is work enough on "peace" materials to keep the shops going a couple of years.

Florida

PENSACOLA.—The Southern Fertilizer and Oil Company has purchased a factory site on which to conduct the manufacture of oil and fertilizer from menhaden fish. The site consists of 95 acres at Grassy Cove, across the bay from Pensacola.

Idaho

HARLEY.—The North Star mill of the Federal Mining & Smelting Company, which has been closed down for a short time in order to install some new machinery and make necessary adjustments, has resumed operations. The entire plant is now in full operation. The material being handled at present is tailings.

Kentucky

IRVINE.—Reported Schell Syndicate, Lexington, will build refinery here to cost between $600,000 and $800,000 and give employment to nearly 1000 men. Work will begin in spring.

LOUISVILLE.—The L. W. Rendering Company will build a $15,000 rendering plant to produce hides, fertilizer, grease, etc. They will need 4 tanks, one press, one boiler, one engine, one elevator, one dryer and one evaporator. Fred E. Hoerter is president and Fred Ehrhart, Norton Bldg., is superintendent.

LOUISVILLE.—The Royal Dutch-Shell Syndicate is planning the construction of a refinery to cost $800,000 at Irvine, Ky.

Louisiana

NEW ORLEANS.—The Freeport & Mexican Fuel Oil Corporation has broken ground for its new plant on the Story plantation. An office building is being erected which will be followed by stills and tanks.

Maryland

BALTIMORE.—The Standard Grease and Glue Company will erect a $100,000 plant in the Curtis Bay District for the manufacture of glue, soap and tankage. George A. Whiting of Baltimore will be president of the new company.

BALTIMORE.—The Union Soap Company, 214 North Pearl Street, plans the erection of a $1,000,000 soap factory at Swann's Park, to take care of large foreign and domestic orders. The company has been in business for forty years and has a large factory in Baltimore. The company was recently reorganized with Horatio Turner, president; Samuel Hogg, vice-president; J. C. Handy, treasurer; and Nathaniel Ewing, general manager.

Massachusetts

SPRINGFIELD.—The Fiberloid Company will increase its preferred capital stock from $1,000,000 to $1,750,000, in order to provide funds for new buildings, machinery and other equipment.

WESTFIELD.—The Marr Paper Corporation of New York has leased Crane's upper mill on the Granville Road and will begin the manufacture of onion skin paper, for which there is a growing demand. Maurice O'Mearea of New York is president; J. B. White of New York, treasurer; F. J. Marshall and Elwood Brinker, both of Easton, Pa., will be in direct charge of manufacturing.

Michigan

MUSKEGON HEIGHTS.—The Campbell, Wyant, Cannon Foundry has leased the foundry buildings of the Racine Boat Works of Muskegon, and is preparing them for immediate use in the manufacture of auto engine castings.

The Enterprise Foundry is completing a three-story foundry for the production of plumbing fittings and castings.

Missouri

ST. JOSEPH.—The St. Joseph Tanning Company is constructing two additional double dry tunnels which will give the plant a daily capacity of 600 to 700 sides of leather.

Montana

BIG FORK.—Work on the construction of a large paper mill to be built by the Glacier Pulp and Paper Company, a new concern organized by St. Paul and Minneapolis financiers, will begin soon. The mill will be erected in the vicinity of large timber tracts controlled by the promoters, and will be operated by water power.

The main office of the concern, whose capital is $100,000, will be in Minneapolis. The new company is backed by E. Warner of the McGill-Warner Company of St. Paul; G. M. and L. S. Gillette and J. F. Jordan of Minneapolis, and W. P. Snow of Big Fork.

New Jersey

NEWARK.—A fire of undetermined origin partly destroyed one of the buildings of the Charles Cooper Chemical Company in South Street on Dec. 26. The building was used for the manufacture of collodion.

NEWARK.—The Union Smelting and Refining Company and the Eagle Smelting and Refining Company of New York, which recently consolidated, have purchased a plot of eleven acres on St. Charles Street, and will remove their plant from New York to the new site. A series of modern fireproof buildings will be erected, the first section of which will cost $250,000. Their products consist of white metals of all kinds, type metal, solder, etc. The New York office is in the Woolworth Bldg.

New York

BUFFALO.—The additions which are being made to the plant of the Schoellkopf Aniline & Chemical Works are being rushed as fast as possible. A five-story research laboratory and office building 53 by 150 ft., has been started, and work will be commenced soon on a large power plant, an ice manufacturing plant and a machine shop as adjuncts to the new manufacturing plant which is being erected. The John W. Cowper Company has charge of the construction work.

LOCKPORT.—New York capitalists have been negotiating for the purchase of the plant formerly occupied by the Lockport Paving Company. It will be used as a pulp mill.

Ohio

CLEVELAND.—The Valley Smelting Company will erect smelting plant at Bradley Rd. and B. & O. R. R.; cost about $125,-000. The company was recently organized with a capital of $250,000. Thirteen acres have been leased at the above location and the plant will be used for smelting and refining waste materials. The officers are Joseph Sillman, president; Charles O. Patch, vice-president and treasurer; J. D. LeBel, assistant secretary and assistant treasurer, and Harrison B. McGraw, secretary.

CLEVELAND.—The Western Chemical Company, of which we had a short note in our last issue, is incorporated under the laws of Ohio with a capital of $25,000. The company is taking over what is known as the Fleming processes, methods supposed to be shorter and less costly. The plant here has been running on Prussian blue, and marketing it in pulp form the past three months, and nothing else will be made at this plant. About 100 lbs. per day is the output.

The Pittsburgh plant is being designed for larger output, 300 lbs. per day, but there the dried and ground product will be produced. Also such chemicals as enter into the products, and also dyes. George H. Fleming is president and P. L. Summers general manager.

COLUMBUS.—The Winslow Glass Company has closed down its plant permanently and will seek another location, because its gas supply has been cut off. The company has been located on the South Side for several years and employs 300 men in making milk bottles.

TIFFIN.—The Standard Oil Company will spend about $50,000 on new buildings to be erected here within a few months.

YOUNGSTOWN.—The Linde Air Products Company has purchased a site here and will erect a plant for the manufacture of oxygen, etc. About 25 men will be employed at the start.

Pennsylvania

BELLEFONTE.—The Hyde City steel rolling mills have been bought by a syndicate of capitalists headed by Dr. C. F. Hennig, of this place, and contractors are at work remodeling and enlarging the plant at a cost of approximately a quarter of a million dollars. The price paid was about $50,000.

The mills are located about two miles from Clearfield and have not been in operation for five or six years. It is the intention of the new owners to convert them into a rolling mill for nickel steel bars and titan bronze tubing. Every effort will be made to have the plant in shape to begin operations early in the spring.

CHARLEROI.—The Charleroi plant of Macbeth-Evans Glass Company resumed operations the last week in December, using oil, for which installation was made, in the place of gas.

DONORA.—The powdered coal system being installed at the Donora plant of the U. S. Steel Corporation is progressing rapidly. An oil system is also being installed. The systems replace gas, the shortage of which caused the mills in this section to shut down.

MIDLAND.—Announcement has been made that the Crucible Steel Company will build a new foundry here at a cost of $75,000.

JOHNSTOWN.—The Cambria Steel Company will spend $7,000,000 on the erection of two new blast furnaces and a new plant to manufacture car wheels. Ground has been broken for the furnaces and work will start shortly on the car wheel plant.

PHILADELPHIA.—S. B. & B. W. Fleisher are erecting a two-story dyehouse to cost $70,000 at Twenty-fifth and Dickinson Streets.

PHILADELPHIA.—The Empire Pulp and Paper Mills Company of Montreal, Canada, has taken over and will operate the old Swanson Bay Pulpwood Manufacturing Company's plant. This plant was erected a few years ago, but only ran a short time. The new management plans to turn out 300 tons of pulp daily.

PHILADELPHIA.—The new firm of Monroe, Lederer & Taussig, which was formed by parties formerly with the Thompson Wood Finishing Company, will manufacture specialty paints and enamels for dipping, brushing, spraying for furniture manufacturers and allied trades. The new plant was expected to be in operation at the first of the year.

PORT ALLEGANY.—Dr. V. Mott Pierce, head of the Pierce Glass Company of Hamburg, has purchased the large plant built by the Olean Glass Company at Port Allegany, Pa., which he expects to operate early in 1917.

SOUTH BETHLEHEM.—The Bethlehem Steel Company announced on Dec. 20 that work would be started on an ingot mould foundry with a capacity of 150,000 tons per annum, to be located at the eastern end of the Saucon plant. The cost of the building and equipment will be about $750,000.

Utah

GARFIELD.—The American Smelting & Refining Company's sulphuric acid plant, which is to make sulphuric acid from the smelter gases, will be put in operation in a short time with an initial capacity of 100 tons per day.

MORONI.—The sugar factory of the People's Sugar Company is now under way. The site is situated one and a half miles south of Moroni in northern Sanpete County on the Denver & Rio Grande Road. It is in the center of a large beet growing area, and is the first sugar factory to be erected in this district.

SALT LAKE CITY.—The Knight sugar factory at Raymond, Canada, is being dismantled by engineers of the Lynch-Cannon Eng. Co. of Utah and the Cannon-Swanson Sugar M'ch'y Co. of Chicago, and will be shipped to Cache County, Utah, where several sites have been offered for its establishment.

SYRACUSE.—George M. Cannon, a real estate man of Salt Lake City, has been making investigations as to the advisability of erecting a beet sugar factory in Davis County near Syracuse.

Washington

NORTH YAKIMA. — The Utah-Idaho Sugar Company is rushing work on its $1,000,000 plant in North Yakima. About 50 tons of lime per day will be needed during the manufacturing season and Mr. Horne, resident agent, has been receiving bids for this material. The silica content must not be over 2 per cent.

SEATTLE. — The American Nitrogen Products Company, C. F. Graff, manager, which has obtained the rights to use the patented electric furnace of F. H. A. Wielgolaski, is putting up a temporary plant of 3000 kw., capacity capable of expansion to 6000 kw., for the fixation of atmospheric nitrogen. Mr. Wielgolaski is engineer in charge. It is understood that the company is still seeking capital.

SEATTLE.—The president of a company owning a brewery in south Seattle announced recently that part of the plant would be equipped for manufacture of industrial alcohol, following the suggestion of an Eastern manufacturer of automobiles. The alcohol plant will be in operation in a few weeks.

SUMNER.—The Northern Board & Paper Mills will erect a 35 x 100-ft. addition to take care of increased demand. The present output of paper board is 28½ tons per day.

West Virginia

WHEELING.—Contracts are being let for work on an $8,000,000 sheet steel plant to be erected by the Whitaker-Glessner Co. at Beech Bottom, near here.

Wyoming

BASIN.—John C. Roberts, manager of the Consumers Oil & Gas Company of Billings, Mont., has announced that his company will start construction in the spring of a large oil refinery at Basin with a capacity of 1000 barrels per day.

Canada

CHICOUTIMI, QUE. — The Chicoutimi Pulp Company will build an addition to its plant here and increase its output from 80,000 to 130,000 tons of pulp per year.

COBALT, ONT.—The Davidson Gold Mines, Ltd., has completed negotiations with a Boston financial house for the sale of a large block of treasury shares to provide funds for the erection of a large mill.

QUATSINO SOUND, ONT.—The Colonial Pulp & Paper Mills, Ltd., will build here a sulphite plant to have a daily capacity of 120 tons. The first unit will have a daily capacity of 60 tons. The installation will be completed in about a year.

VANCOUVER, B. C.—The American Consul in British Columbia has sent in to the Bureau of Foreign and Domestic Commerce the following note in regard to the purchase of a smelter by American capitalists:

"The Ladysmith smelter, formerly operated by the Tyee Copper Company, an English concern, has been purchased by American capitalists, and as soon as extensions and improvements involving an outlay of $100,000 can be made the plant will be put into operation.

"Efforts have been made for some time by local organizations interested in the development of mines on Vancouver Island to induce the Provincial Government to take steps for the opening of the Ladysmith smelter. With its extensions it will soon be in full operation and will employ more than 100 men. Facilities provided by the extensions will enable it to turn out blister copper, whereas formerly it could produce only copper matte. Mine operators on Vancouver Island have been sending their ores to the smelter at Tacoma, Wash., for treatment, and with the operation of the Ladysmith smelter the necessity for this will be obviated.

"It is stated that the Tacoma smelter is very busy, and if it is offered more business than it can handle the mine producers on Vancouver Island would find their smelter facilities curtailed without some arrangement on Vancouver Island.

"The new owners propose to make the plant thoroughly modern and install converters. Blister copper, instead of being sent out of the Province, probably will be treated by large interior refineries. The capacity of the Ladysmith smelter is 700 tons, but will be greatly increased."

ST. JOHN, N. B.—The Partington Pulp & Paper Co. (Ltd.), of St. John, New Brunswick, has sold its mill and timberlands to interests in the United States for about $3,000,000. The purchase includes 372,000 acres of spruce and fir wood and 1,000,000 ft. of hardwood. The entire tract of timberland comprises nearly 30,000,000 cords of wood. The purchasers are incorporating a new company, which proposes at an early date to increase the output of the Partington sulphite mill from 60 to 80 tons of bleached sulphite pulp daily. It is understood that the principal object of the purchasers was the acquisition of the timberlands.

Manufacturers' Notes

RUST PREVENTIVE PAINTS. — The Harrisburg Chemical and Paint Company, Inc., 917 Hemlock Street, Harrisburg, Pa., which recently enlarged its plant is specializing on Rust Prevento Oil, Rust Prevento Paints and Damp Prevento Concrete Dressing. These products have been the subject of various tests in acids, gases, etc., and have proven satisfactory preventives.

The oil can be applied either upon new metal or metal that is already corroded.

Tests have been made during the past six years, under all sorts of conditions, which have given a wide range of the various ways in which it can be used, not only upon iron and steel, but upon tin, nickel plating, etc.

PULVERIZED COAL EQUIPMENT.—The Fuller Engineering Co., Allentown, Pa., have contract for pulverized coal equipment for American Steel and Wire Co., Donora Steel Works, Donora, Pa., in connection with eight 60-ton open-hearth furnaces; for pulverized coal equipment for heating furnaces of the American Works of the American Steel and Wire Co., at Cleveland, Ohio, and pulverized coal equipment for two open-hearth furnaces in No. 1 Lehigh Plant of the Bethlehem Steel Co., South Bethlehem.

SOUTHERN STATES ENDORSE MUSCLE SHOALS FOR GOVERNMENT NITRATE PLANT.—The Southern Commercial Congress unanimously adopted resolutions on Dec. 13 endorsing Muscle Shoals as the best available site for the government nitrate plant. The committee's recommendation was made after considering other sites, and it represents the endorsement of the South for the Muscle Shoals location. Muscle Shoals has been described in this journal in connection with the proposal of the American Cyanamid Co., to build a factory there and supply the government with all requirements of nitric acid. It is the only place in the South where 120,000 hp. could be developed 24 hours a day. It is the only Southern location that has received any consideration from the War Department engineers.

PUBLISHERS IN TEXAS AND LOUISIANA CONSIDERING ESTABLISHMENT OF PAPER MILL.—In many parts of the country publishers have held meetings to consider the advisability of establishing cooperative paper mills, to counteract the high cost of paper. In California, West Virginia and other states the movement has been on foot for some time. The latest section to take up the question includes Texas and Louisiana. After the holidays were over a meeting of the publishers of Texas and Louisiana was to be held in Beaumont to discuss the feasibility of the plan and to gather authentic data on the value of gulf coast products for making print paper. Sweet gum wood is mentioned as one of the probable raw materials from which paper can be made.

SOUTHERN TURPENTINE PRODUCERS ORGANIZE.—Turpentine manufacturing interests of Louisiana, Mississippi and Texas met in New Orleans Dec. 20 and decided to organize the turpentine producers association, to be operated on a similar basis to that of the Southern Pine Association.

Charles F. Speh of Washington called the conference. H. H. Gordon, president of the Independent Naval Stores Company of Lake Charles, presided, and about 75 per cent of the crop of these three states was represented. A committee on organization, consisting of D. J. Gay, Biloxi; J. A. Taylor, New Orleans; L. N. Dantzler, Pascagoula, and L. H. Guerre, Bogalusa, was appointed by Chairman Gordon, which will formulate the plan and report back early in January.

Among prominent naval stores producers present were: N. B. Corbett, Fullerton, La.; E. M. Pringle, Glen Mora, La.; V. G. Phillips, Provencal, La.; W. A. Hood, Pine Bur, La.

GLASS PLANT FORCED TO LEAVE COLUMBUS.—The Winslow Glass Company, Ohio, which employs 300 men in making milk bottles has been forced to shut down its plant and seek another location owing to the shutting off of its gas supply.

SHORTAGE OF NATURAL GAS IN INDIANA.—The blowing of colored glass will be discontinued at the plant of the Johnston Window Glass Company, Hartford, Ind., on account of the unreliability of the natural gas supply, the only fuel which can be used to advantage in the manufacture of this article. About fifty employees will be thrown out of work in this line by the decision of the company.

ENGLAND WILL BID FOR LARGE CHEMICAL TRADE AFTER WAR.—That England will make a strong endeavor to secure a big export business in chemicals after the war is the belief of those familiar with conditions and developments in that country. It is more than likely that the free-trade policy will be abandoned as duties are considered essential for the building up of the chemical industries. There has been a remarkable development in chemical manufacturing in England since the war began, and many factories which are supplying war needs can be converted to making various products.

1916 GREATEST EXPORT YEAR.—Manufactures were exported from the United States in 1916 to a value greater than the value ever exported by any country. It is estimated that the year's total was considerably in excess of $3,000,000,-000. The highest export record ever made by Great Britain was $2,012,000,000 in 1913, the year immediately preceding the war. Prior to the war, the United States held third rank. In 1914 our exports amounted to $974,000,000 and in 1915 to $1,784,000,000. A statement of the National City Bank is as follows:

"The growth in exports since the beginning of the war is, of course, due in a considerable degree to the demands for strictly war material, explosives alone being for 1916 approximately $675,000,000, brass tubes for the manufacture of shells $225,-000,000; while in many other articles, such as automobiles and various articles of iron and steel there is also a large increase, though just what proportion of the growth is due to the demands of the war can only be estimated. Of iron and steel manufactures of all kinds the exports of the full year show a total of approximately $900,-000,000 against $200,000,000 in 1914."

In the view of the bank, the experiences of the year just ended demonstrated the ability of the manufacturers of the United States to supply a much larger proportion of the manufactures entering world consumption than they have in the past, since the total value of the manufactures which they exported in 1916 was approximately 40 per cent of the total manufactures entering international trade in normal years as against approximately 15 per cent which this country's manufacturers supplied in the year just preceding the war. The report showed that prior to the war the percentage which manufactures formed of the domestic exports of Great Britain was 79 per cent, Germany 67 per cent, France 58 per cent, and of the United States 47 per cent. Manufactures formed 15 per cent of American domestic exports in 1880, 21 per cent in 1890, 35 per cent in 1900, 45 per cent in 1910, 49 per cent in 1913 and approximately 66 per cent in 1916.

MEETING OF TUNGSTEN PRODUCERS.—At a meeting of a special committee of the tungsten producers of this State, appointed by President Wells and composed of the following members, Harold Boericke, Primos N. & M. Co., Boulder; J. A. McKenna, Vasco Mining Company, Boulder; Robert M. Keeney, Rare Metals Ore Company, Denver; J. G. Clark, Boulder Tungsten Produce Co., Boulder; William Loach, Wolf Tongue Mfg. Co., Boulder; Forbes Rickard, Ragged Top Mfg. Co., Denver; Platt Rogers, Rogers Patent, Denver; Horace Holmes, Luckie 2 Mfg. Co., Boulder; Geo. W. Teal, Tungsten Metals Co., Boulder; Wm. Cowdry, Long Chance Mfg. Co., Nederland; Nelson Franklin, Rare Metals Ore Co., Rollinsville; N. H. Brown, Mojave-Boulder Tungsten Mfg. Co., Sugar Loaf, it was decided to call a meeting of the tungsten producers of the United States to convene during the annual meeting of the Colorado Metal Mining Association, to be held in Denver Jan. 9, 10 and 11, 1917. This meeting was called for the purpose of a conference of the tungsten producers of the country to formulate a plan for concerted action in all matters affecting the industry and especially to unite in an effort to secure as early as possible favorable action on the part of the proposed Tariff Commission in behalf of a duty on tungsten ores and the products thereof.

SALES CONVENTION OF THE KENNEDY VALVE MANUFACTURING COMPANY.—The sales force of The Kennedy Valve Manufacturing Co. convened at its office in Elmira, N. Y., on Dec. 14 and 15. A most interesting and enthusiastic convention was held. It was the first time that many of the salesmen had met the new sales manager, Mr. J. L. Peden. On the morning of the first day the entire company of salesmen and managers made a tour of inspection through the company's plant, which is located on a plot covering twenty acres. In the afternoon arguments were heard pro and con, and in the evening a dinner was given at the Country Club in Elmira. The meeting was unanimously voted to have been the most successful ever

held by The Kennedy Valve Manufacturing Co., and re..ected great credit on the several executives who had it in charge.

FRENCH CONCERN WANTS CATALOGS.—Mr. Jacques Vieyra, 24 Rue de Lubeck, Paris, France, is desirous of receiving catalogs and literature on electric appliances and supplies (not motors or generators); laboratory supplies for industrial, chemical and metallurgical work, with a view to taking up the importation and sale of a portion of the goods mentioned throughout France and her colonies.

FOREIGN TRADE OPPORTUNITIES.—The following opportunities for foreign trade have appeared in recent Commerce Reports.

23,382—A firm in Spain wishes to represent American manufacturers and exporters of dyestuffs used in coloring cotton, woolen and silk textiles. The firm also desires to purchase on its own account. Cash will be paid against documents. Quotations should be made c.i.f. destination. Correspondence may be in English. Reference.

23,385—A man in Spain wishes to purchase dyestuffs for the textile industry. Cash will be paid against documents. Quotations should be made f.o.b. New York or c.i.f. destination. Correspondence may be in English. References.

23,387—A man in Venezuela wishes to purchase machines for making glue, as a by-product of a tannery. Machines are desired with a capacity of about 275 lb. per day. Correspondence is preferred in Spanish, but may be in English.

23,394—A man in the British West Indies desires to be placed in communication with American manufacturers of small power cane mills and fiber vessels of 1 cu. ft. capacity.

23,396—A business man in Switzerland would like to purchase several tank cars, with a capacity of 4000 to 6000 gal., for oils, petroleum, etc. The cars are to be constructed in compliance with the specifications of the Swiss Federal Railways. Quotations should be made c.i.f. European port. Cash will be paid against documents. Correspondence should be in French or German. References.

23,401—A company in India wishes to receive catalogs and full information from American manufacturers of modern aerated water plants. Quotations are desired c.i.f. foreign port. Correspondence may be in English. Reference.

23,403—A man in Spain is desirous of representing American manufacturers and exporters of varnishes, colors and drugs. Correspondence may be in English. References.

23,424—An engineer in Norway desires to secure a sole agency for the sale of iron and steel and materials of all kinds used by engineers and builders. Quotations should be made f. o. b. American port or c.i.f. destination. Correspondence may be in English. Reference.

SWITZERLAND TO CONTROL ITS LEATHER TRADE.—The Swiss Government, according to the U. S. Consul at Berne, has undertaken the protection of the leather supply of the country, and its first step has been to place the country's shoe factories under the control of the Department of Agriculture and the War Office, to fix maximum prices for the shoe and leather trade, and issue directions to the tanners regarding the preparation of the hides and skins. Licenses hereafter issued by the Swiss Political Department will not only enable business men to buy skins and hides of inland slaughter and at prices and conditions fixed by the government, but will insure deliveries of stocks held by dealers, as the law provides that stocks cannot be withheld from buyers with licenses. Only goods that cannot be used in the country may be exported, according to the provisions of the new law. The new maximum prices do not affect running contracts.

MEETING OF OBEX LABORATORIES.—A meeting of the stockholders of The Obex Laboratories Co. was held at the offices of the company, Marietta, Ohio, on Tuesday, Jan. 2. Mr. G. A. La Vallee, president of the company, read a report summarizing the year's work, which report showed a highly successful year. It was voted to change the name of the company to "The Obex Company," and the capital stock was increased from $200,000 to $750,000. A new board of seven directors was elected, consisting of the following members: Judge E. B. Follett, R. M. Noll, J. H. McCoy, C. J. La Vallee, C. B. Ballard and G. A. La Vallee, all of Marietta, and A. Alexander of New York City. All of the products of the company are sold exclusively through the National Gum & Mica Co.

ANNUAL CONVENTION OF VANADIUM-ALLOYS CO.—On January 3, 1917, at the Pittsburgh Athletic Association occurred the Annual Convention and Banquet of the

Sales Representatives of the Vanadium-Alloys Steel Company, Pittsburgh, Pa., who manufacture high speed, carbon and alloy tool steel, and some very interesting topics were thoroughly discussed, the most prominent being a paper on "Crucible Tool Steel," read by Roy C. McKenna, president of the company. The following day a trip to the mills at Latrobe, Pa., was enjoyed by all of the representatives, after which the salesmen returned to their respective posts in the United States and Canada.

Manufacturers' Catalogs

Other New Publications

GOLD, SILVER, COPPER, LEAD AND ZINC IN IDAHO AND WASHINGTON IN 1915. By C. N. Gerry. U. S. Geological Survey Report. Part of Mineral Resources of U. S. for 1915

METALS AND ORES IN 1914 AND 1915. By J. P. Dunlop. U. S. Geological Survey Report. Mineral Resources of U. S.

GOLD, SILVER, COPPER, LEAD AND ZINC IN NEVADA IN 1915. By V. C. Heikes. U. S. Geological Survey Report. Mineral Resources of U. S.

COKE IN 1915. By C. E. Lesher. U. S. Geological Survey Report. Part of mineral resources of U. S. for 1915.

PETROLEUM IN 1915. By John D. Northrop. U. S. Geological Survey Report. Part of Mineral Resources of the U. S.

MOLYBDENUM: ITS ORES AND THEIR CONCENTRATION, with a Discussion of Markets, Prices, and Uses, by Frederick W. Horton. Bureau of Mines Bulletin 111.

MAGNESITE IN 1915. By Charles G. Yale. U. S. Geological Survey Report. Published December 19, 1916. Part of Mineral Resources of U. S.

COPPER IN 1915. General report. By B. S. Butler. U. S. Geological Survey Report. Published December 20, 1916. Part of Mineral Resources of U. S.

MAGNESIUM IN 1915. By Frank L. Hess. U. S. Geological Survey Report. Published December 21, 1916. Part of Mineral Resources of U. S.

CLAY-WORKING INDUSTRIES AND BUILDING OPERATIONS IN THE LARGER CITIES IN 1915. By Jefferson Middleton. U. S Geological Survey Report. Published December 22, 1916. Part of Mineral Resources of U. S.

BORAX IN 1915. By Charles G. Yale. U. S. Geological Survey Report. Published December 18, 1916. Part of Mineral Resources of U. S.

COAL IN 1915. PART A. PRODUCTION. By C. E. Lesher. U. S. Geological Survey Report. Published December 16, 1916. Part of Mineral Resources of U. S.

NATURAL GAS IN 1915. By John D. Northrup. U. S. Geological Survey Report. Published December 29, 1916. Part of Mineral Resources of U. S.

COAL IN 1915. PART B. DISTRIBUTION AND CONSUMPTION. By C. E. Lesher. U. S. Geological Survey Report. Published December 28, 1916. Part of Mineral Resources of U. S.

OPERATING DETAILS OF GAS PRODUCERS.—By R. H. Fernald. Bureau of Mines Bulletin 109.

Mr. Fernald discusses the producer-gas-plant situation as it exists in the country to-day and also compares the producer-gas plant with the steam turbine.

Although, as might be expected, a great deal of indefiniteness exists regarding many of the operating details, and few, if any, cost data are available, it is believed that in this bulletin sufficient detailed information is presented to provoke wholesome discussion on the part of those interested in this form of power.